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Hope of Reward Vital to Utility Progress

PROFITS in the usual sense are not a part of public utility compensation for service rendered. Within the power industry it is generally appreciated that the monetary reward of service furnished boils down to a return on the investment sufficient to attract new capital into the field. In the transfer of properties from one ownership to another profits may accrue as in the sale of any other going business, but the earnings of utilities are pretty sharply restricted to a rather moderate return on the rate base. The stability of such enterprises helps to make the investor satisfied with a lower return than he would often accept in other fields. If profits are denied to the industry in the usual commercial sense, it must none the less offer rewards to enterprising management if it is not too stagnate. This is a point which many people unfamiliar with the intimate problems of the power business either fail to grasp or refuse to see.

In an ordinary retail business the surplus of income remaining after all expenses are met may be listed as profits, but in the utility field such a surplus is a "horse of another color." In a private business there are no limitations upon the dividend disbursements which may be authorized except the judgment of the management, but in the power industry the interest of the customer is so closely tied into the situation that the idea of "charging all the traffic will bear" has become intolerable to modern high-grade management. What, then, are the rewards so essential to progress in the supply of electricity as a service invested with quasi-public responsibilities?

The rewards are both tangible and intangible. Samuel Ferguson has translated them at Hartford into a sharing of surplus from operations with the customer, the employee and the stockholder. The Western Massachusetts Companies has shared the benefits of operation under a holding organization with the public as well as with its security holders, and the same thing has been done in innumerable other cases. Material reward expressed in moderate advances in dividends coupled with the improvement of service, good treatment of employees and lower prices for electricity should arouse nothing but approval on the part of those who believe in that encouragement of initiative which has been the cornerstone of development in American industrial civilization.

Unfortunately carping critics are all too plentiful who seem to believe that *all* the savings of efficient and alert management and high-class engineering should be turned over to the public. It will be a sorry day for the power industry if this viewpoint ever becomes general. The intangible rewards of engaging in a service as interesting as electrical supply are sufficient to keep a good many men in the industry who might amass far more money in other fields, but utility men and women should make it clear to laymen that a fair division of surplus resulting from first-class management means nothing more than justice to all the parties and interests involved in the production and distribution of electricity.

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Along Comes Cambridge

LESS than two weeks after the city of Gloucester, Mass., administered a solar-plexus blow to a proposed municipal ownership plan, the neighboring city of Cambridge delivered a *coup de grace* to a similar program sponsored by a small group of politicians who finally appear to have read popular handwriting on the wall to the effect that the public in the Bay State is not in the least enthusiastic over the tax increases which municipal ownership bids fair to establish under present conditions. It is nothing unusual now for two places in the same state to turn the cold shoulder to municipal ownership at approximately the same time, considering the annual mortality of such enterprises, but these Bay State decisions are significant on account of the anti-utility agitation which has been drummed up by various public officials and their political supporters during the past two years.

It is a reasonable assumption that the people of Massachusetts are on the whole well satisfied with the cost and quality of electric service rendered them by private companies under state regulation and that the noisy kicking against the pricks by agitators which has furnished so many newspaper headlines during the past months carries with it very little popular backing. It would be absurd to maintain that the power industry in this or any other state stands in need of no improvements in policy or practice—cases can be cited where better management would benefit both the com-

panies and their customers—but by and large the cost of electric service bulks too small in the living budget of domestic and business customers to interest either class in wielding the club of municipal ownership over the heads of the company managers. For the present the political tribesmen will have to beat some other kind of a tomtom to attract the attention of the rank and file of the voters.

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More Data on Diesel Engines Needed to Reach Economic Conclusions

CONSIDERABLE debate has occurred regarding the economy of Diesel engines for power production. Such debate might leave the impression that these prime movers have been singled out for attack. Possibly they have been so dealt with by some individuals and companies. But broad-minded electric utility company men are contesting the economy of Diesel engines, not because they are Diesels, but because inaccurate accounting for total operating expense is prevalent, leading many times to erroneous conclusions.

First cost, fixed charges (particularly obsolescence) and expenses for maintenance and repair are the chief factors attacked. While depreciation may be within the range often quoted, obsolescence is quite a different figure, because it depends upon the rate of development of new equipment and competitive service and not upon the rate of physical depreciation.

One objection that some engineers have to the installation costs quoted for isolated plants is that inadequate provision is made for rendering continuous service through the medium of reserve equipment and repair facilities.

The average user insists on 15 per cent fixed charges —97 per cent of the users, according to a survey, maintaining that the investment must be amortized out of savings in four years and 44 per cent say it must be amortized in two years.

Repairs and maintenance average 11.2 mills per kilowatt-hour, but it is interesting to observe that maintenance expenses are usually low where an adequate amount is spent for attendance.

Operating performance varies widely, depending on load factor and operating conditions. Average values mean nothing. Fuel-oil consumption ranges from 0.616 pound to 0.888 pound per kilowatt-hour, lubricating oil from 0.00019 gallon to 0.008 gallon per kilowatt-hour, and cooling-water expense depends on location.

If a potential customer for purchased energy is definitely set on producing his own power, refusing to accept the existing evidence of economic disadvantage, it would aid greatly in assembling more authentic data if the utility men handling the case would solicit his co-operation in keeping accurate over-all costs of operation.

Stability and "Synchronized at the Load"

WHILE many papers are being written and many discussions are taking place about the best methods of tying and synchronizing large generators to reduce the short-circuit current and to maintain stability of the system, The United Electric Light & Power Company in New York has taken the bull by the horns and established a system which is synchronized at the load. It has been in operation now for about ten months. At the last meeting of the "Power Group" of the New York Section of the A.I.E.E. very remarkable results from the operation of this system were reported—more remarkable because of the very short time which the system has been in operation.

Actual failures which happened very recently seem to prove conclusively that the voltage drops at all points of the system during a short circuit are considerably less when the system is operating "synchronized at the load" than with the older bus system. This holds good for substations close to Hell Gate and Sherman Creek as well as for some remote substations in Queens and Westchester. "Synchronized at the load" is a success, and the United Electric is to be congratulated upon having had the courage to undertake such a radical change on such an important system.

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Poor Store Lighting Brings Its Own Penalty

ADEQUATE and proper illumination has as much to commend it now as when the art first started. In fact, it has gained importance with the years and, because of changed conditions, is more necessary today than it was a decade or two ago. More people work by and rely upon artificial light now than formerly, and for reasons of safety as well as for maximum production, good illumination is generally recognized as essential.

But does the merchant who neglects to show his wares under proper light realize the extent of his folly and what it costs him? Apparently not, for if he did, store interiors would be as well lighted as store windows. Department-store surveys show that from 20 to 25 per cent of the goods purchased on credit and 6 per cent of the goods purchased for cash are returned. Moreover, and here's the rub, analysis indicates that the high percentage of returned goods is due many times to inadequate lighting. What a commentary on the business acumen of men primarily merchants, and what a challenge to the lighting experts of public utility companies and to manufacturers of lighting equipment! From the electrical end a change from poor to proper illumination may not mean much, but from the merchant's viewpoint it means a lot. Service which falls so far short of the ideal should be rectified as quickly as possible.

Distribution, Horizontal and Vertical

THE alternating-current network is now firmly intrenched as a type of distribution which fulfills the requirements of a wide range of load densities. Some fifty properties, from New York with its 100,000 kw. per square mile to cities of only 40,000 population with corresponding load densities of only 1,000 kw. per square mile, have proved the merits of the practice. But it has taken the new spurt in skyscraper construction to call attention to the economic possibilities of subjecting electric distribution to the same upending process as that to which we have resorted in converting horizontal subway tubes to vertical elevator wells. In one of the giants now racing for height supremacy in New York the three-phase, 13-kv. feeders direct from station buses will rise directly to transformer vaults located at appropriate levels in the structure. The secondary will be networked with all the burn-free, self-restoring propensities of its horizontal progenitor.

In all sincerity we ask, why should not the vertically stratified town housed in the structure of Leviathan height be served from the same type of distribution system as would be employed for the same load in a few correspondingly compact blocks? There can be no question of the improved reliability and economic saving in tons of copper and thousands of dollars. Nor should there be any deterrents in the direction of safety. It is known just how much commotion occurs when a network fault burns clear and means are at hand for disposing of whatever heat and fumes emanate from the process.

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Fostering Co-operation Between Architects and Engineers

TWO precedents have recently been established by the New York Section of the Illuminating Engineering Society which should have very valuable results. The last meeting under the auspices of the committee on home lighting was held in the home of Condé Nast, publisher of *House and Garden*, thus establishing a relationship between the Illuminating Engineering Society and the press which is primarily interested in beautifying the home. Such an exchange of ideas should prove to be of great benefit to both. The second precedent, which is much more significant and bids fair to be of great benefit both to architecture and to the art of illumination, was to have the most important papers delivered by two prominent architects rather than illuminating engineers.

Closer co-operation between the architect and the illuminating engineer has been advocated by the ELECTRICAL WORLD on many occasions, but its advent has been slow. The architect very often tackles the illumination problem and even the electric circuit problem without the advice of the illuminating or electrical engineer. In turn the illuminating engineer and, all too often, the contractor or fixture manufacturer have handled the artistic side of lighting without consulting the architect. The results in very many cases have been architectural atrocities, artistic monstrosities and engineering absurdities.

If the relationship established by the Illuminating Engineering Society is continued, and if the architects continue to be as frank and as rational in their criticism as they were at the last meeting, a new and beautiful art of illumination may be expected to take shape and persist.

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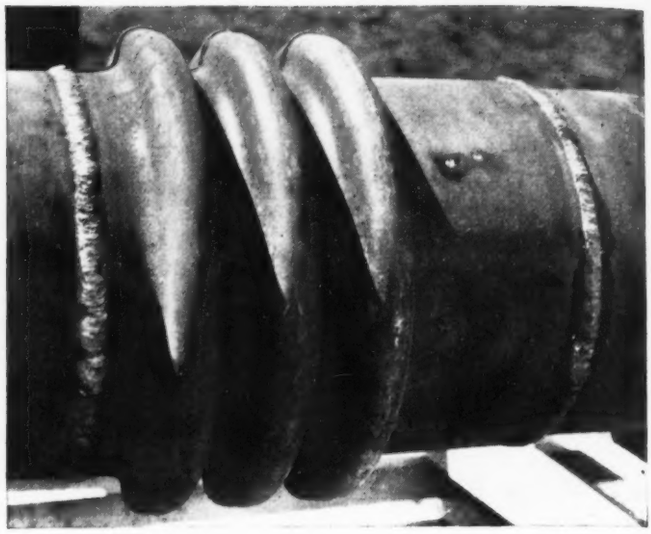
Perspective Vital in Engineering

PARAMOUNT among the qualifications of the successful engineer is the ability to establish a sharp perspective in analyzing problems for present solution. Mental focusing power, according to a recent address of Alex Dow before the Harvard Engineering Society on "Engineering and Business," is peculiarly an attribute of leadership in this profession. Translated into ordinary terms, this means that the ideal engineer, as President Davis of Stevens Institute has said, should be able to analyze a problem into its fundamentals, respect facts, reach conclusions based on facts and possess an instinct for choosing the proper combination of money, facts and men. Without despising the unorthodox "hunch," it is most essential to work on the basis of reasoning, and before this can be done a clarified definition of every problem that arises must be achieved.

"All intelligent people have reverse gears and are willing to change decisions upon reasonable proof of error." This graphic expression of the dean of the electrical industry in Detroit is a good text in itself for a day's thinking. It is significant, however, that sharp-focus analysis of engineering situations reduces the likelihood of error by an amazing percentage. Engineering success involves a belief in accuracy tempered with an understanding of what can be done. Ninety per cent accuracy with the desired speed is much better in economic affairs than one hundred per cent accuracy coupled with prolonged delay. A sense of perspective is invaluable.

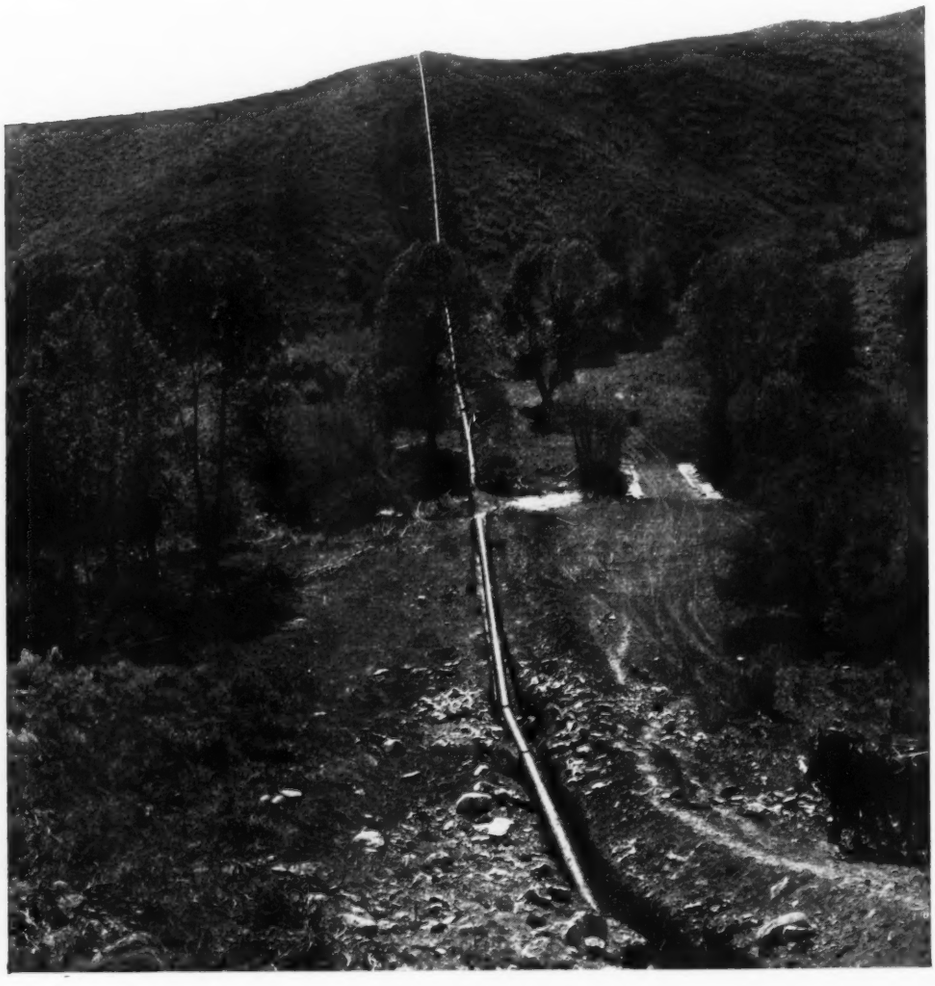
Thus one constantly returns to the importance of correct focus in dealing with engineering problems. Here lies the basic difference between a purely political and an engineering administration. Engineering has its roots in ascertainable facts; it is an honorable profession, and while its practitioners are human, "fuzzy" thinking is to them intolerable and the pursuit of truth the only right objective. The qualifications of success set forth by Alex Dow at Harvard University are of course no monopoly of engineering, but they are distinctive and essential to its practice as one of the learned professions.

Long Pipe Lines Suited to Electric Welding



FLEXIBLE expansion joints are an important feature of the 277-mile natural gas pipe line from Rock Springs, Wyo., to Salt Lake City, Utah. Portable 300-amp. gas-engine-driven welders were used.

Another long line, 624 miles, involving 46,728 joints, showed but three small pinholes when subjected to rigid inspection and tests by line owners and welding contractors.



Minimizing Fault Damage Within Generators

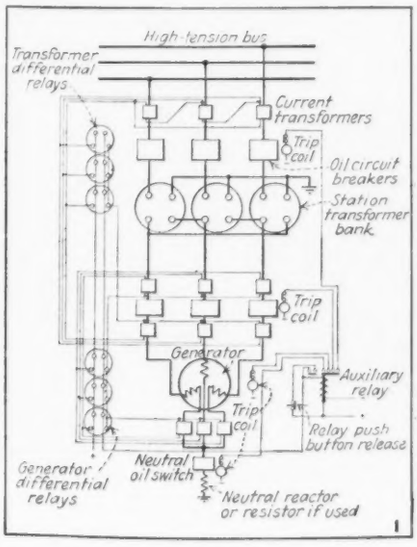
By Lloyd F. Hunt
Department of Engineering Design, Southern California Edison Company, Los Angeles, Calif.

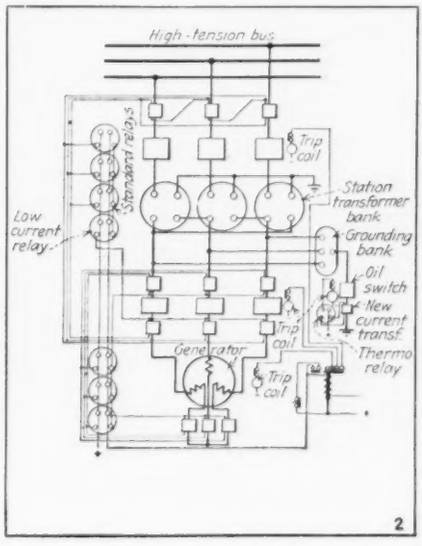
Two types of differential protection are compared with a scheme which does not automatically drop machine but gives audible signal of trouble

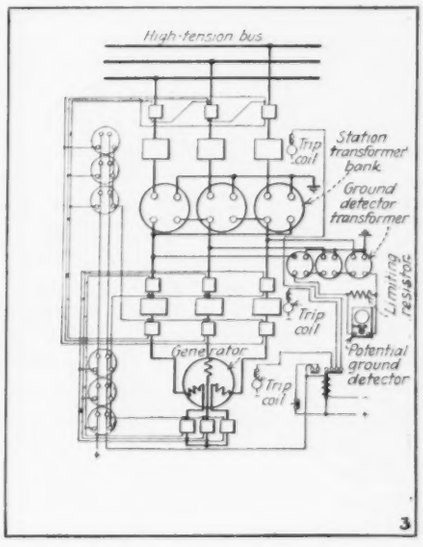
SINCE a very high percentage of electrical failures in generators are phase-to-ground faults rather than phase-to-phase faults, it is important that adequate protection be provided against ground faults. Differential protection of generators may clear the machine from the line in case of a ground fault, but if the generator neutral remains externally grounded there is a possibility of damage to the machine after it has been tripped off the line and even after the field has been disconnected also. This is due to the fact that residual magnetism in the field may maintain sufficient voltage to produce an arc and perhaps serious damage to the machine. That is to say, when there is a ground in a generator merely clearing it from the line without opening the external ground connection does not necessarily protect the machine against internal damage.

When generators are star wound, the neutrals usually are solidly grounded, although sometimes they are grounded through reactors. In either case a failure to ground in the machine will cause clearing by differential relays. However, the fault will not be isolated for the reason just mentioned. The usual differential protection applied to generators will clear the machine from the line in case of phase-to-phase or phase-to-ground faults, but since probably 90 per cent of generator faults are phase-to-ground faults, and since merely clearing the machine from the line by differential protection will not necessarily protect against internal damage, three methods of limiting current flow into ground faults are proposed:

Disconnecting Neutral Ground.—This scheme makes use of disconnecting the ground from the generator neutral by means of an oil switch with or without limiting resistor or reactor, as shown in Fig. 1. In the case of ground trouble with the neutral solidly grounded, the damage to the machine may be greater after it has been disconnected by differential relays than during the time required for relay operation. This is due to the fact that the generator field takes several seconds to die out







Audible Signal in Generator Ground Protection Minimizes Fault Damage

Fig 1—Differential protection with oil switch in generator grounded neutral.
Fig. 2—Grounding bank and differential relays protect generator.
Fig. 3—Ground detector gives audible signal and permits load to be transferred to another machine.

and in some cases residual magnetism is sufficient to do harm. Should a limiting resistor or reactor be used the effect is the same, but due to the current-limiting feature of the resistance or reactor the total damage is much less. This shows the importance of disconnecting the generator neutral from ground by automatic oil switch controlled by the differential protection.

The size of an oil switch used to open a solidly grounded neutral must be large, as its duty when operated simultaneously with the line and field breakers may be very high. The short-circuit capacity of this oil switch is determined by the size and reactance of the generator, transformer and other parts of the system. When using a limiting resistor or reactor in the neutral the oil switch is required to handle only the limited fault current, thus reducing the duty. The cost of either of these installations would be high and the oil circuit breaker might have to be so located as to endanger the generator should failure occur.

Grounding Bank Method.—This method takes advantage of the ground current flowing from a grounding bank. It may be seen from Fig. 2 that on the generator side of the transformers the neutral of the grounding bank is the only point grounded, the generator neutral being ungrounded. The size of the grounding bank is determined by the setting of differential relays. The purpose of the grounding bank, besides establishing a neutral to ground potential, is to cause sufficient ground current to flow in a phase-to-ground fault to trip differential relays. The value of ground current necessary is not as large as may be suspected.

The differential protection of a generator may be made very sensitive as the two sets of current transformers can be identical, thus eliminating possibility of tripping on external short circuits. Differential protection for transformers, however, is normally less sensitive as the difference in high and low side current transformers may be sufficient to cause a faulty operation on an external short circuit. Therefore, in this scheme it will be necessary to add a fourth relay in the transformer differential as shown in Fig. 2. This relay should be of the low current range type. With a through short circuit, even though the current transformers on the low and high side are not exactly matched, the three currents add up to zero at the neutral point of the three relays, thus no current will flow through the sensitive relay.

The probability of ground failure in the machine near the neutral end of the winding is so small that a compromise on the size of grounding bank must be made. For example, should a ground fault occur at the midpoint of one phase, the ground current then would be approximately one-half that flowing with ground fault occurring at the terminals of the machine. Since it is possible that a ground may occur in the winding of the generator, at a voltage so low as to cause insufficient current to flow for tripping the differential relays and yet cause enough current to flow to damage the grounding bank, it is necessary to equip the grounding bank with a neutral oil switch operated from a thermo relay having thermal characteristics similar to the transformer.

The grounding bank used in this scheme should be connected solidly to the station transformer bus at a point inside the transformer differential. When connected in such a manner should a failure occur in the grounding bank, it would be cleared from the system by the station transformer differential protection. However, when generator and transformers are operated as a unit a ground fault current flowing in the generator would also flow in the neutral relay of the station transformer differential protection. Therefore, if it is felt desirable to keep the transformer on the line when a fault occurs in the generator, the ground relay could be set a little longer in time so as to allow the generator to clear. This additional time is not harmful as the current supplied by the grounding bank is very small compared with the short-circuit current of the generator and station transformers. In the case of two generators feeding one transformer bank, this additional time given in the setting of the ground relay is highly necessary.

Should this method be employed when distribution circuits are taken off the generator bus, it is necessary to connect the grounding bank on the bus. The feeders also should be equipped with a sensitive ground relay so that in case a ground fault occurs the feeders would automatically be disconnected.

This scheme has the advantage of limiting the ground fault current to any amount desired and yet will quickly isolate faulty apparatus.

Ground Detector Method.—The potential ground detector as developed and patented by the author several years ago and as shown in Fig. 3 is based upon measuring the zero sequence voltage with a voltmeter calibrated to read in per cent ground. In addition to the voltmeter there is provided on the same panel a relay which closes an audible signal circuit for grounds of 10 per cent and above. A push button shunts out an external voltmeter resistance to change the range of the meter from 0-100 per cent to 0-10 per cent to give a more accurate indication on low values of ground.

The potential transformers used with this method of protection should be of such size that their full load current will not allow arcing grounds. The current flow necessary to prevent the possibility of arcing grounds is small and depends upon the circuit to which the scheme is applied. In order to make this full load current flow, a resistor of proper value is placed in the open of the delta of the transformer grounding bank. If three $2\frac{1}{2}$-kw., 11,000/110-volt transformers be used, the full load current of the 110-volt winding would be 22.5 amp., and it would be necessary to use a resistor capable of carrying 22.5 amp. at 200 volts continuously.

Operation of the scheme is as follows: Should a ground occur on the generator bus or the low side of the transformers, the potential ground detector gives an audible signal. When generator and transformers are operated as a unit as shown, the trouble could be in the generator, transformers or bus. Immediately upon getting a signal of a grounded condition, the operator shifts the load to another machine and drops the machine apparently in trouble from the bus. The ground detector then indicates whether the trouble is in the machine, on the bus or in the transformers. Then by dropping the transformer bank and picking up the bus with the machine the trouble can be definitely located.

Audible Signal Permits Load Transfer

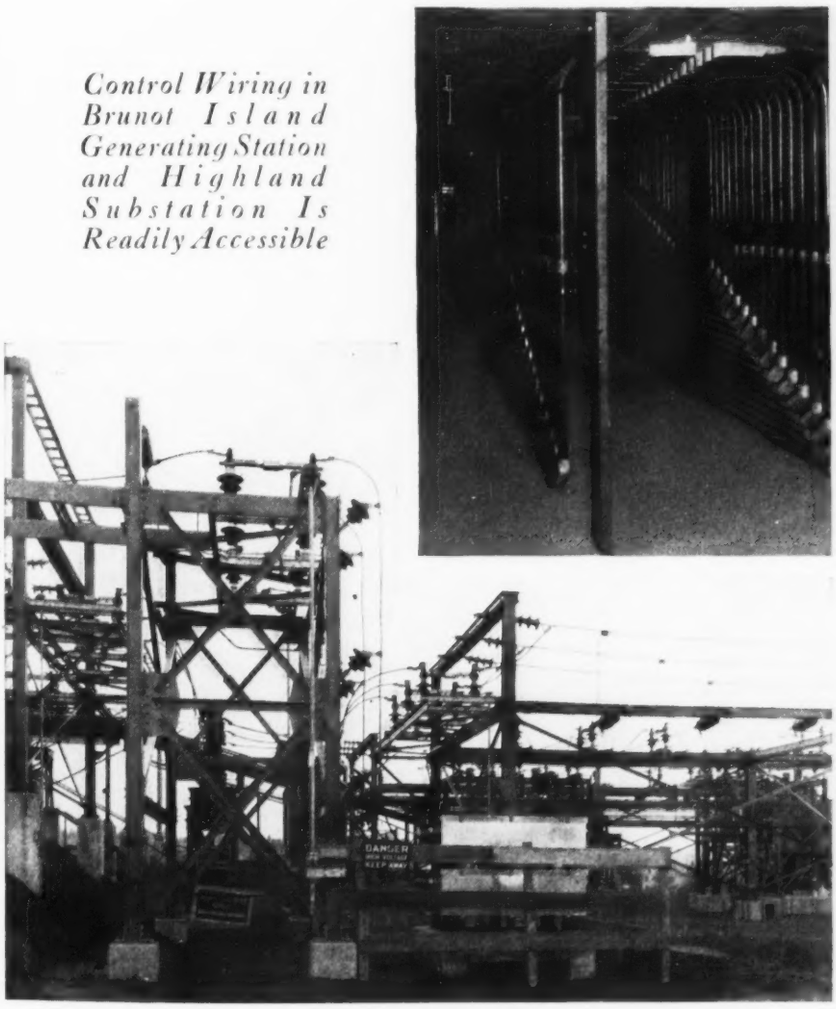
In addition to the nominal cost of this method of protection it has the advantage that a ground fault will not cause the machine to be tripped off the line immediately but, instead, there will usually be sufficient time to transfer the load to another machine, thus reducing the possibility of system disturbance. On many systems the dropping of fully loaded machines of sizes from 50,000 to 100,000 kva. by differential protection will

cause a system disturbance before the load is readjusted.

In the application of the three methods of ground protection above described, it must be understood that they do not in any way displace the differential protection usually employed. Differential protection is necessary in the first two schemes to clear the machine from the line in case of either phase-to-phase or phase-to-ground faults, and in the latter or ground detector method to give protection against phase-to-phase faults.

Exposed Conduit Advocated for Control Wires

INSTEAD of burying control-wire conduit in the ground of outdoor substations or in the concrete floor of generating stations and substations, the Byllesby Engineering & Management Corporation uses exposed conduit extensively. Such construction is shown for two installations—Brunot Island generating station and the Highland substation of the Duquesne Light Company.



Control Wiring in Brunot Island Generating Station and Highland Substation Is Readily Accessible

The exposed construction avoids the difficulty of finding space for a mass of conduit in floors and makes the control wiring more readily removable after it has been installed a long time, as conduit couplings and any section of conduit can be easily removed. Furthermore, it is easy to add other control wires at any time.

Cost of Faults on Street-Lighting Cable

By T. G. Hieronymus
Underground System Engineer
Kansas City Power & Light Company, Kansas City, Mo.

THE preponderantly fortuitous character of fault occurrences on street-lighting cable laid in the ground is strikingly brought out by the accompanying table of fault costs. One way in which fortune, good or bad, enters into the consideration is shown by the utter lack of relationship between total costs of repairs and damages collected. Aside from the adventitious nature of the item of damages collected, the causes of the faults themselves rest largely upon chance, being mostly outside of any condition of the cable itself. In other words, the pick wielded by a husky laborer and driven through a cable is not in any way related to the condition of the cable dielectric caused by electronic bombardment. Street-lighting cable faults usually rest on mechanical causes outside the cable; certainly no inherent causes can be deduced from the data covering the experience of the Kansas City Power & Light Company, here presented.

This experience indicates small efficacy for protective coverings from simple jute over rubber to double steel tape armor over lead with jute bedding and outer layers. The life of these protective coverings is generally dependent upon the methods employed during installation and the aggressiveness of chemical and electrolysis action after installation. The chemical activity of soils varies greatly with different cities and to a considerable extent in different locations in the same city. The soil of Kansas City has been found to be injurious to jute coverings impregnated with vegetable compounds. The cable installed locally is a No. 8, one-conductor, paper-insulated, lead-covered cable with three layers of jute over the lead. No steel tapes are used. The jute affords mechanical protection during handling and installation. It offers protection against electrolytic action by insulating the sections of cable from each other where they enter the lamp base or are in the same trench.

Local experience has been that all trouble on this cable is from actual mechanical damage by workmen excavating or driving tools, etc., into the cable. In many cases a deliberate attempt is made to cut the cable in two, mistaking it for a tree root. Very few of the cases of trouble could have been avoided had steel tape been used for added protection. Since the three layers of jute often are found rotted away after a short while—even as short a time as three years—it is doubtful if the steel tape could have lasted much longer. Certainly it could not offer much protection after chemical action had started. It has been found better to try to educate the

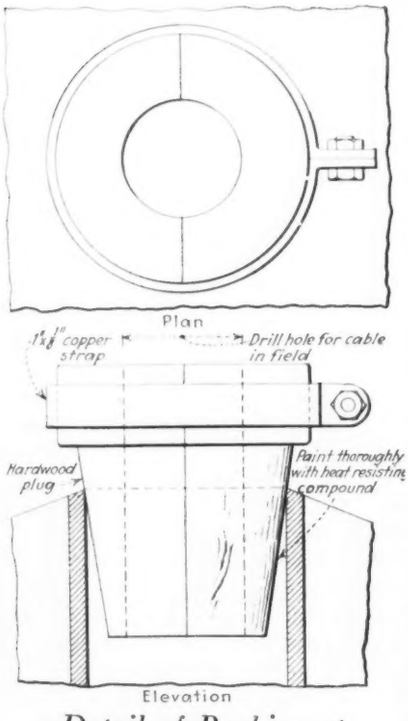
Street-Lighting Cable Faults Costly

Year	Feet Cable Operating	No. Failures of Cable	Total Cost of Repairs	Damages Collected	Total Net Cost	Average Net Cost per Failure	Average Net Cost per Ft. of Total Cable
1923	784,355	118	$2,083.50	$1,727.19	$356.31	$3.0196	$0.00045
1924	784,204	101	2,667.93	1,128.22	1539.71	15.2447	0.00197
1925	812,889	122	3,403.83	1,840.65	1563.18	12.8124	0.00193
1926	854,456	186	5,416.94	2,545.00	2871.74	15.4405	0.00330
1927	910,484	107	3,293.55	1,156.92	2136.63	19.9685	0.00234
1928	975,348	162	5,223.72	1,090.61	4133.11	25.5730	0.00424

workmen to recognize cable when they see it and caution them of its presence in the ground than attempt to put on enough armor so the cable cannot be damaged.

The analysis of the cost of cable failures shows that from an economical standpoint we can afford to spend only approximately 2 cents per foot per year additional for complete protection against damage of all kinds. This is based on capitalizing the cost of damages at 15 per cent per year. The table shows the actual costs of failures. From it may be noted the fact that the number of failures is not increasing proportionally to the increasing amount of installed cable even though the jute coverings are deteriorating.

Simple Bushing for Underground Duct



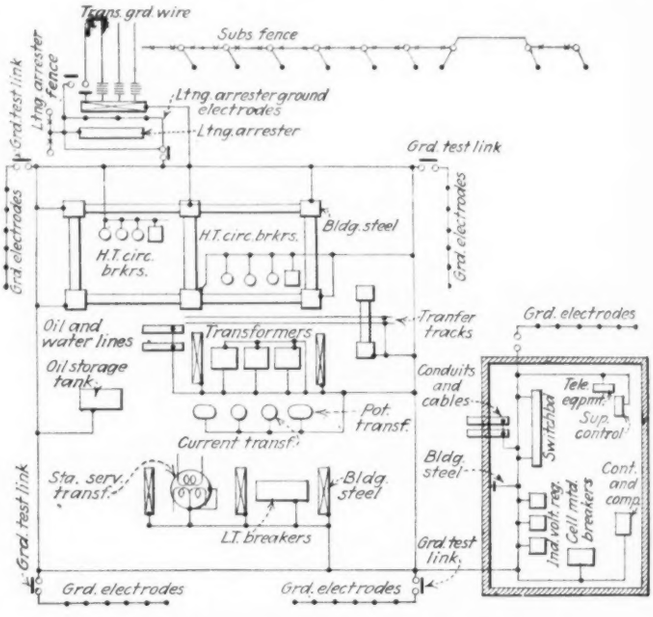
Detail of Bushing at Duct Terminal

THE open end of an underground fiber duct serving as a conduit for lead-covered cable was terminated with a bushing which was easily made up in the field on an Eastern construction job, the details being shown in the accompanying drawing. The end of the fiber duct was trimmed off flush with the sloping surface of the concrete envelope. The inner surface of the fiber conduit and the outer surface of the plug were coated with a liberal layer of heat-resistant compound. A tapered hardwood plug, split in half, was inserted in the duct. The hole for the cable was drilled in the field, care being taken not to force the plug into the end of the duct hard enough to split the fiber. After this the cable was pulled in place, connected with its terminal and clamped in the bushing by a 1-in. x $\frac{1}{8}$-in. copper strap, bolted at the end.

Improved Maintenance of Station Grounds

CERTAIN initial inspections and tests should be made of grounds and ground connections at each new station and after important changes in any existing stations. These are (1) measurements of resistance of ground electrodes and of total station ground resistance; (2) inspection of grounding systems to see that the provisions of the code are met with in all respects.

The report of these inspections and tests should be accompanied by a sketch, such as the one accompanying



Typical Outdoor Substation Grounding Layout for Analysis of Conditions

this article, showing the arrangement of the ground electrodes, buses and ground connections with essential dimensions to enable buried parts to be located unless such parts are marked in the field.

The following procedure is recommended for the routine inspection of grounds by one operating department: (1) Maintenance men are required to make a visual inspection of the groundings of each station as a part of the regular maintenance schedule; (2) if suitable instruments are available ground resistances should be measured at least once every year.

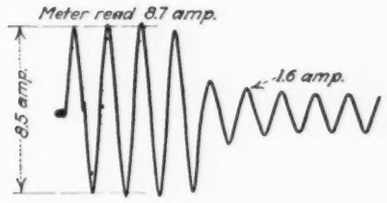
Where grounds are treated with chemicals to lower the resistance, tests and inspections must be made more frequently than in locations where better soil conditions are met. It is most desirable to keep well below the values of resistance given in the table published in a previous installment of this series in ELECTRICAL WORLD for September 7, 1929.

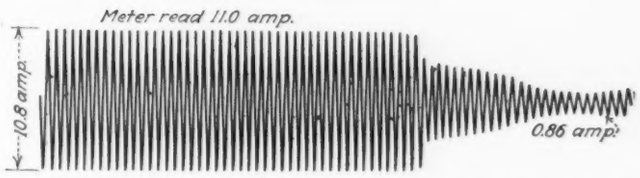
It is also desirable that these values do not take into account the conductivity obtained from a multiple grounded transmission neutral or ground wire, as these may become disconnected. In case these values are exceeded additional electrodes should be installed immediately. Where it is not possible to lower the ground resistance, the most effective means possible should be used to prevent the existence of dangerous voltage gradients.

Measuring Motor-Starting Currents

A new ammeter developed to measure currents of short duration. Test data on starting and locked rotor currents. Applicable to fractional-horsepower motors and larger

By B. H. SMITH
Westinghouse Electric & Manufacturing Company





Figs. 2 and 3—Small-Motor Starting Current without and with Load

A WELL-DAMPED ammeter in series with an electric motor, either alternating current or direct current, will register a considerable "kick" when the motor is started and then will settle down to a much lower indication as soon as the motor is up to speed. If the motor is carrying a load the starting current may persist for a large fraction of a second or longer, perhaps long enough for an observer to obtain a quite accurate reading of the starting current. If the motor starts with no load or if it is a small-sized motor the duration of the starting current will probably be so short that the meter will read considerably less than the value which will be shown by an oscillograph. If the motor is held so that it cannot rotate and voltage applied a considerably higher reading will be obtained. This reading is ordinarily termed the "locked rotor" value on alternating-current motors. However, the locked rotor value is not really as good an indication of the effect on electrical circuits of the abnormal current due to motor starting or of the blinking of lights, which may be connected to the same source occasioned by this abnormal overload, as is the reading of the well-damped ammeter mentioned above. The reason is evident and is a result of the inherent time element of the instrument which corresponds very acceptably to the actual effect on the lighting circuit. For this reason various engineering societies have defined starting current as the reading obtained on a well-damped ammeter.

Nevertheless it is extremely interesting to study the starting characteristics of various motors under different conditions, and it is often quite necessary to know the locked rotor value as well as the starting current. The instrument shown in the accompanying illustration is an adaptation of a standard portable instrument which is especially well fitted to read both these values. It has a highly efficient air damper and a light moving element, which is not too greatly affected by inertia. An attachment consisting of a simple back stop for the pointer enables the movement to be held at approximately the value of the initial rush of current when a motor is started. If two or three trials of the starting current are made it is comparatively easy to find just the right point where the needle barely leaves the stop when the motor is started, and thus determine with remarkable precision the locked rotor value without locking the rotor. This latter is of special value in large-sized motors which are not easily locked. This important reading can be taken even on a 50-hp. motor with an accuracy within 2 or 3 per cent of that obtainable with an oscillograph.

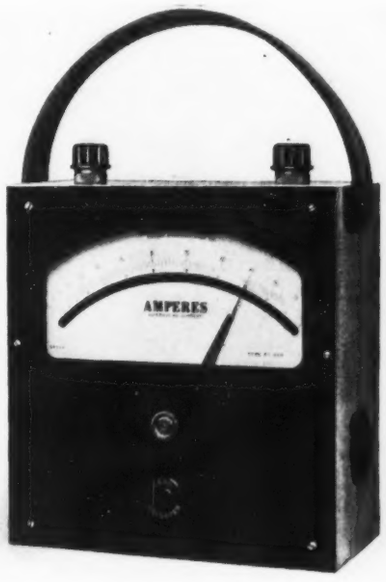


Fig. 1—Ammeter for Measuring Motor-Starting Current

In order to read the starting current on a "well-damped ammeter" it is only necessary to turn the back stop to zero and start the motor again. The damping factor and inertia of the instrument movement furnish sufficient time delay to integrate the variable current flowing in the first fraction of a second and give a starting current reading, which is of great value in determining the condition of the motor.

An oscillogram of a small motor starting without load is shown in Fig. 2. One of the ammeters connected in the rotor circuit when this oscillogram was taken, with the pointer back stop in service, gave a reading of 8.6 amp., while the oscillograph indicates practically the same value. Fig. 3 shows

the starting current characteristics of a similar motor with load. In this case the initial rush of current lasted almost long enough to enable the observer to obtain a fairly accurate reading with an ordinary ammeter, but with the new device mentioned it is possible to be doubly sure of

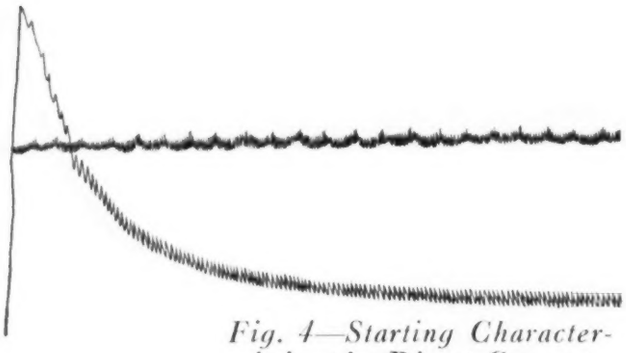


Fig. 4—Starting Characteristics of a Direct-Current Motor

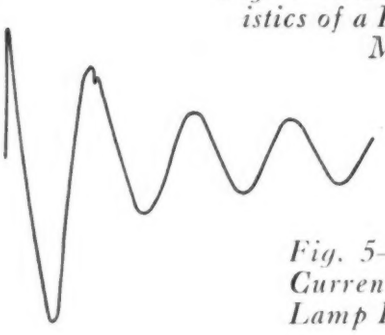


Fig. 5—Rush of Current When a Lamp Is Lighted

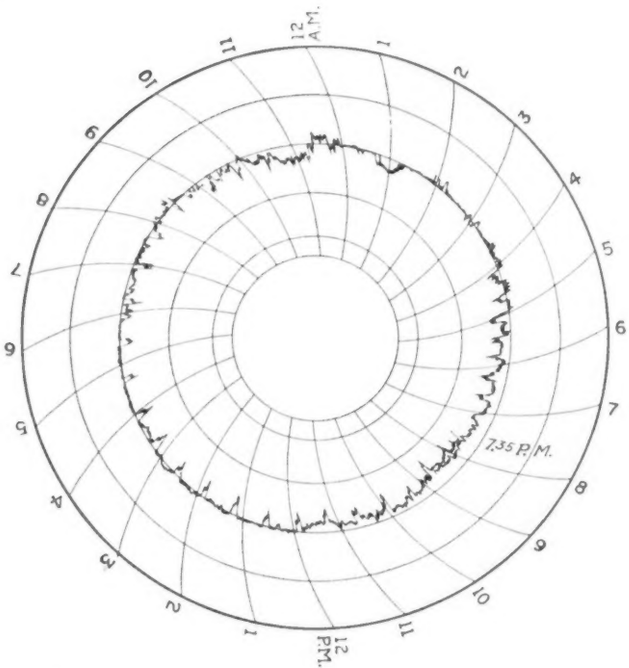


Fig. 6—Motor Operation with Voltage On and Off

the correctness of the indication. Direct-current motors generally start very quickly and the characteristics are somewhat different as shown in the oscillogram of Fig. 4. Here again the instrument with the pointer stop indicates with remarkable precision and agrees with the oscillograph indication. Then to read the running current on any of these motors it is only necessary to turn the back stop to zero. The instrument illustrated is double range and if the running current is too low on the scale it is only necessary to turn the switch on the right-hand side of the meter to the low range. The motor continues running as this operation does not open the circuit.

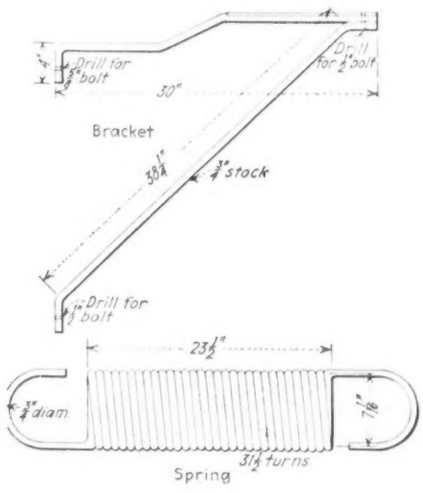
There are other fields for such an instrument. In fact, any abnormal change which persists for only a fraction of a second can be indicated with good accuracy. Fig. 5 shows the rush of current which persists for an exceedingly small length of time when a tungsten lamp is turned on. The maximum current persists for over one cycle and yet the meter gives a correct indication of this initial current.

Fig. 6 shows the starting of a small motor followed by an interruption of the supply voltage with the power applied again before the motor came to rest, resulting in a rush of current of extremely short duration. This high current was again measured correctly by the ammeter.

In certain tests of relays and other apparatus it is sometimes desirable to investigate their ability to withstand currents of perhaps 100 times normal for perhaps one-half second. It is quite difficult to make the test set-ups and adjust the circuits to give the correct current making use of ordinary ammeters. With the instrument illustrated, tests calling for 500-amp. on a 5-amp. winding for various fractions of a second have been made and the circuits adjusted so quickly that there was not too much overheating of the various instruments before the real test was started.

Expansion Bend in Aerial Cable Line

IN SOME instances difficulties are created by the thermal expansion of aerial cables. The kinks subject joints to unusual stresses and occasionally electrical failure results. The Syracuse Lighting Company has guarded against such annoyance and loss by providing for a U-bend in the cable at the pole. The center of the bend is supported in a cradle which can slide (at right angles to the cable run) in a groove in a bracket arm.



Bracket and Spring for Cable Expansion Loop

Bracket arm is of ⅜x2-in. wrought iron and the spring of ¾-in. spring steel having an elastic limit of 80,000 lb. per square inch.

The tension is maintained by clamping to the cable a spring that is made of ¾-in. wire coiled to a diameter of 7 in. and about 24 in. long. Maintenance of the tension prevents creep of the cable or hangers.

Diesel Engines for Peak Loads

By Dr. P. H. Schweitzer
Pennsylvania State College

Based on actual operating costs of American central stations, Dr. P. H. Schweitzer has analyzed the power costs of "mixed central stations" and found that by combined steam-Diesel operation considerable saving can be effected. While some figures selected may be considered too low by some operators and too high by others, substitution of other figures will not affect the results appreciably. In the issue of last week Dr. Schweitzer discussed the general problem of economically caring for peak loads. This article deals with this use of the Diesel as a peak load device in utility stations

IN A previous article the general problem of peak load was discussed and the advantages of the Diesel engine outlined. It was shown that a saving could be made by using special equipment to handle peak loads. In this article the cost analysis is carried out in detail based on the best available data.

The thermal efficiency of steam turbine units depends largely on the load factor. In the analysis of this factor the curve suggested by Fernald and Orrok is used in Fig. 5. For the heating value of 1 lb. of coal 12,500 B.t.u. was taken. As investment cost $125 per kilowatt was chosen, which includes machinery installation, buildings and land.

It should be pointed out that the assumption of a uniform figure for investment cost per kilowatt capacity of the whole system is not always justified. In case of expanding existing stations some of the existing equipment ought to be taken at a much lower investment cost due to its obsolescence. No actual computations can be made without due consideration to the existing equipment. The following computations only hold strictly when an entirely new station is built with nothing on hand or if addition is considered to a station which consists of modern units only.

The fixed charges were computed on the basis of 7 per cent interest, 2 per cent taxes and insurance and 2.44 to 3.97 per cent for a sinking fund for depreciation and obsolescence. This corresponds to a useful life of twenty to fifteen years respectively. A faster depreciation was taken for higher capacity factors. Attendance and maintenance costs were determined on a kilowatt-hour basis, but with due regard to the load or capacity factor. It is obvious that the utilization of labor is less efficient when part of the equipment is idle or used part time only. Some men will always be idle, others will be busy banking some boilers and keeping in shape other boilers and machinery without actually generating energy. Records of operating performances bear this out. From Alden's tabulation of the operating costs of 136 American steam central stations, which probably represents the most complete and reliable information on power generating costs, nineteen stations, which fall be-

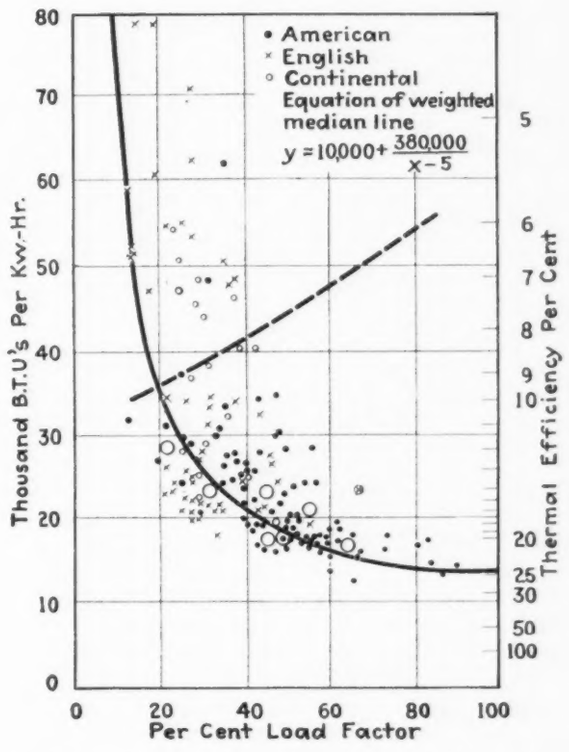


Fig. 5—Relation of Thermal Efficiencies of Steam Turbine Stations to Load Factors

The curve is a weighted median based on about 200 stations. All central stations in Alden's table (Electrical World, September 26, 1925), larger than 15,000 kw. and built since 1923, listed are marked with large circles. The B.t.u. consumption at total output is very close to a straight Willan's line.

Table I—How Items of Steam Turbine Generating Expense Vary with Plant Capacity Factor (20,000-kw. Plant)

Plant capacity factor, per cent	10	20	30	40	50	60	70
Yearly output, million kw.-hr.	17.5	35.0	52.5	70.0	87.6	105.0	122.5
Investment per kw.-hr.				$125			
Interest on investment, per cent				7			
Depreciation and obsolescence, per cent investment	2.44	2.44	2.44	2.44	3.97	3.97	3.97
Taxes and insurance, per cent investment				2			
Total fixed charges, per cent investment	11.44	11.44	11.44	11.44	12.97	12.97	12.97
Fixed charges per kw.-hr., cents	1.60	0.82	0.54	0.41	0.37	0.31	0.26
Attencance per kw.-hr, cents	0.30	0.19	0.12	0.10	0.09	0.08	0.08
Maintenance per kw.-hr., cents	0.1	0.08	0.06	0.04	0.04	0.03	0.03
Lubricant and miscellaneous, per kw.-hr., cents	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Cost of fuel per Kw.-hr., cents — Coal $2 per ton	0.36	0.21	0.16	0.13	0.11	0.11	0.10
Coal $4 per ton	0.72	0.43	0.32	0.26	0.232	0.22	0.21
12,500 B.t.u's per lb. — Coal $6 per ton	0.98	0.64	0.48	0.39	0.348	0.33	0.31
Coal $8 per ton	1.44	0.86	0.64	0.52	0.464	0.44	0.42
Total cost per kw.-hr. generated, cents — $2 coal	2.37	1.32	0.89	0.69	0.62	0.54	0.48
$4 coal	2.73	1.54	1.05	0.82	0.74	0.65	0.59
$6 coal	3.09	1.75	1.21	0.95	0.86	0.76	0.69
$8 coal	3.45	1.97	1.37	1.08	0.98	0.87	0.80

Table II—How Diesel Generating Costs Are Affected by Current Capacity Factors

Cost of power generated by Diesel engines of 5,000-kw. capacity

Plant capacity factor	10	20	30	40	50	60	70
Yearly output million kw.-hr.	4.38	8.76	13.12	17.5	21.9	26.14	30.7
Investment per kw. capacity				$150.00			
Interest, per cent investment				7			
Depreciation and obsolescence, per cent investment	1.58	1.58	2.44	2.44	2.44	2.44	3.97
Taxes and insurance, per cent investment				2			
Total fixed charges, per cent investment	10.58	10.58	11.44	11.44	11.44	11.44	12.97
Fixed charges per kw.-hr., cents	1.81	0.90	0.65	0.44	0.39	0.33	0.32
Attendance, per kw.-hr., cents	0.55	0.50	0.45	0.4	0.35	0.30	0.25
Maintenance, per kw.-hr., cents	0.34	0.32	0.30	0.28	0.26	0.24	0.22
Lubricant and miscellaneous, per kw.-hr., cents	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Cost of fuel per kw.-hr., cents (0.7 lb. per kw.-hr., 7.5 lb. per gal.):							
Oil 3 cents per gal.				0.28			
Oil 4 cents per gal.				0.37			
Oil 5 cents per gal.				0.47			
Oil 6 cents per gal.				0.56			
Total cost per kilowatt-hour generated, cents							
3-cent oil	3.02	2.04	1.72	1.49	1.32	1.19	1.10
4-cent oil	3.11	2.13	1.81	1.58	1.41	1.28	1.21
5-cent oil	3.21	2.23	1.91	1.68	1.51	1.38	1.30
6-cent oil	3.30	2.32	2.00	1.77	1.60	1.47	1.39

tween 15,000 and 25,000 kilowatts installed generator rating, have been selected. The various cost items are plotted against the annual plant and load factor in Fig. 6.

The curves show the relation of various cost items to the annual load factor, but we are more interested in their relation to the plant capacity factor, which has a greater importance with regard to power costs. Therefore the cost curves have been replotted on the basis of capacity factor, assuming 41 per cent excess capacity, which represents the average of the nineteen 15,000 to 25,000-kw. stations tabulated.

Table IV—Estimated Cost of a Four-Unit, 15,000-Hp., 10,000-Kw. Diesel Plant

(E. B. Pollister)

Real estate	$10,000
Building, including 20-ton crane	75,000
Foundations	40,000
Four 3,750-b. h.p. Diesel engines, f.o.b. point of manufacture	900,000
Freight on engines at $1 per hundred weight	40,000
Generators and exciters, direct-driven	100,000
Freight on generators and exciters	5,000
Unloading and placing on foundations	15,000
Erection	15,000
Station piping	15,000
Cooling-water system (if required)	25,000
Fuel storage	10,000
Switchboard and wiring	20,000
Miscellaneous items, contingencies, and engineering	80,000
Total	**$1,350,000**
Diesel station cost per kilowatt of installed capacity	$135

The power costs so computed are tabulated in Table I. The total net cost of generating 1 kw.-hr. at the bus ranges from 0.42 cent with $2 coal to 0.79 cent with $8 coal at 70 per cent plant capacity factor. With lower capacity factors the costs increase rapidly. These figures represent good modern practice.

Diesel Costs

Similar procedure was used in obtaining cost figures on Diesel operation. For a basis a 5,000-kw. unit was considered. The figures, however, hold true for 2,000 kw. or 20,000 kw. Diesel units as well, because the investment costs are approximately in proportion to the engine capacity and the fuel efficiency is practically the same with small and large units. Records of large Diesel engine operating costs are not yet available in sufficiently large numbers and the estimates are frequently

Table III—Diesel Power Costs from Different Sources

	Fixed Charges		**Fuel**	**Lubricant**	**Miscellaneous Supplies**	**Attendance**	**Maintenance**
Authority	Inst. Cost per Kw.	Yearly Rate, per Cent	Lb. per Kw.-Hr.	Kw.-Hr. per Gal.	Cents per Kw.-Hr.	Cents per Kw.-Hr.	Cents per Kw.-Hr.
N.E.L.A. serial report, September, 1927	$150(1)	15	0.75(4)	800(4)	0.05	0.34	0.25
Diesel Engine Users' Assoc. Report, February, 1928	.....	.....	0.724(5)	600(5)	0.0425(6)	0.318(6)	0.216(6)
Electrical World, September 26, 1925	.....	.....	0.930(7)	.....	0.06(7)	0.38(9)	0.226(9)
Thuerk, "Diesel Engine Power Costs," Electrical World, March 5, 1927	150(1)	15	0.75(4)	800(4)	0.06	0.34	0.325
E. B. Pollister, "Economical Field for Large Diesel Engines," Transactions A.S.M.E., 1928, OYP-50-11	135(2)	.....	.....	.....	.....	.....	.....
Fernanlt and Orrok, "Engineering of Power Plants"	115(1)	11	0.75	940	.....	.....	0.279
Geoffrey Porter, *Engineer*, February 3, 1928	.....	.....	0.7	1500	0.024	0.16	0.09
Edgar J. Kates	160(12)	.....	0.7	1500	0.006(13)	0.165	0.062
A. Büchi, Z.V.D.O. August 7, 1926	72.50(2)	10.1-12.6(8)	0.64	.....	.....	0.27-0.53(8)	0.107-0.198
M. Geroke, E.T.Z., 1927, page 929	48.4(3)	9.0	0.57	.....	.....	0.1-0.65(8)	.....
Busch-Sulzer, Catalog	150(2)	9.6	0.7	2000	.....	0.085(10)	0.069(10)
Fairbanks Morse Catalog	.....	11.72	0.75	1200	.....	0.32	0.03
Report on oil engine power cost for 1927-1928 on 27 plants 210-300 kw. report A.S.M.E. committee on oil engine power costs	.....	7.6	0.785	2010	0.063	0.282	0.066
Figure selected in calculations	150(2)	10.58-12.97(8)	0.7	1500	0	0.25-0.55(8)	0.22-0.34(8)

1. Without buildings. 2. With building and land. 3. Without building and land. 4. For load factors less than 50 per cent. 5. Average of 52 stations. 6. Average of 41 British stations. 7. Medium value of fifteen stations 40-2,040-kw. peak load capacity. 8. According to capacity factor. 9. Average of seven stations over 300-kw. capacity. 10. At 40 per cent load factor. 11. Includes maintenance. 12. For 100-kw. plant. 13. Water only.

conflicting. In Table III estimates of Diesel power costs given by a number of authorities are tabulated and compromise figures chosen.

Items of power costs and the total power costs per

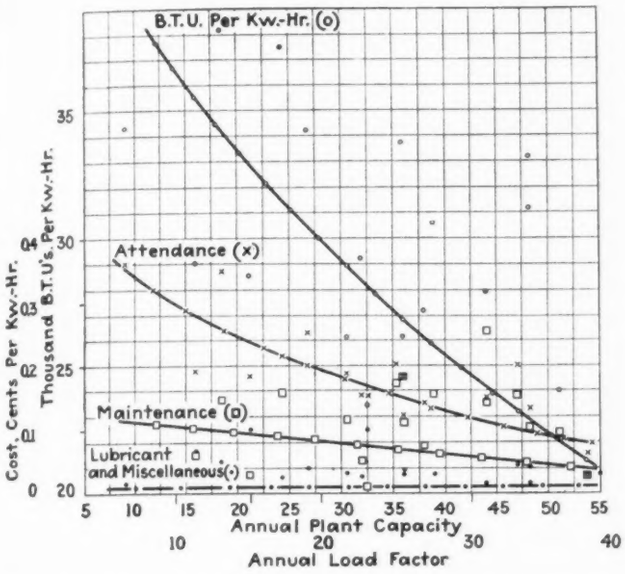


Fig. 6—How Nineteen Steam-Turbine Stations Are Affected by Plant and Load Factor

kilowatt-hour with fuel costing 3 to 6 cents a gallon for various plant capacity factors are shown in Table II. According to the characteristics of the Diesel engine, the fuel consumption is the same for part-time use as for full-time use. The running engine capacity factor does not affect the fuel economy appreciably either, because the thermal efficiency is practically unchanged from three-quarters to full load and only slightly less at half load. Therefore it is justifiable to consider the fuel costs per kilowatt-hour constant with Diesel operation.

Basis for Making Diesel Cost Analysis

The investment required for Diesel installations was taken as $150 per kilowatt, including real estate, buildings, engines, generators, erection and all accessories. Perhaps this figure is somewhat lower than Diesel installations cost a few years ago, but it is higher than the equipment costs today. The cost of a 10,000-kw. Diesel installation given by E. B. Pollister* in Table IV is considered an excellent estimate, but is $15 per kilowatt lower than the one used.

Fixed charges vary with the amount of use. Interest is taken at 7 per cent, taxes and insurance 2 per cent, sinking fund for depreciation and obsolescence was calculated, assuming a useful life of 25 years, at 10 and 20 per cent capacity factors, twenty years life at 30, 40, 50 and 60 per cent capacity factors and fifteen years at 70 per cent capacity factor. At the end of the given period the value of the equipment, including building and real estate, is considered zero. Considering the fact that Diesel engines twenty and 25 years old are still in satisfactory operation, the fixed charges will perhaps be criticised as being too high. However, similar rates were used computing the steam power costs, except that at low capacity factors lower average useful life was assumed because the deterioration of boilers is taking place while they are idle or being banked.

For attendance, maintenance, lubricants and miscellaneous supplies compromise figures were used, proper consideration being given to the capacity factor.

The total costs per kilowatt-hour vary from 1.11 cents at 3-cent oil and 70 per cent capacity factor to 3.30 cents at 6-cent oil and 10 per cent capacity factor.

Independent Analyses of Steam and Diesel Give Wrong Picture

Both steam and Diesel generating costs are plotted against plant capacity factors in Fig. 7. It is readily seen that the steam operation is decidedly more economical over the entire practical field. Four-dollar coal beats the 3-cent oil under any operating conditions. On first consideration the case of the Diesel seems to be hopeless.

However, this conclusion will prove to be entirely wrong on further analysis. In order to decide the economy of the Diesel engine as a peak unit one has to investigate the generating costs with combined operation. We have to base the analysis on actual load curves and subdivide the kilowatt-hours generated into two classifications—the energy generated by the base unit and the energy generated by the peak unit. The total production cost is the sum total of the two separate costs. This calculation has been carried out for the four typical load curves shown in the December 21 issue, page 1214.

The result is rather surprising. Diesel peak units offer marked savings compared with pure steam operation. Although Diesel production costs are higher, the steam-Diesel stations are able to produce power at a lower cost than pure steam stations.

The explanation of the paradox may be found by

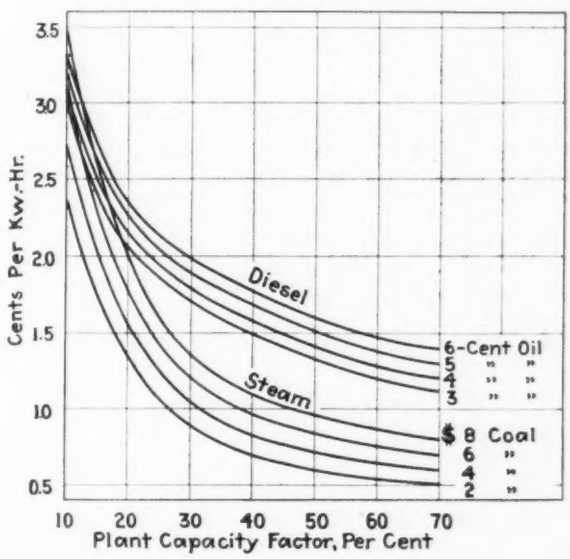
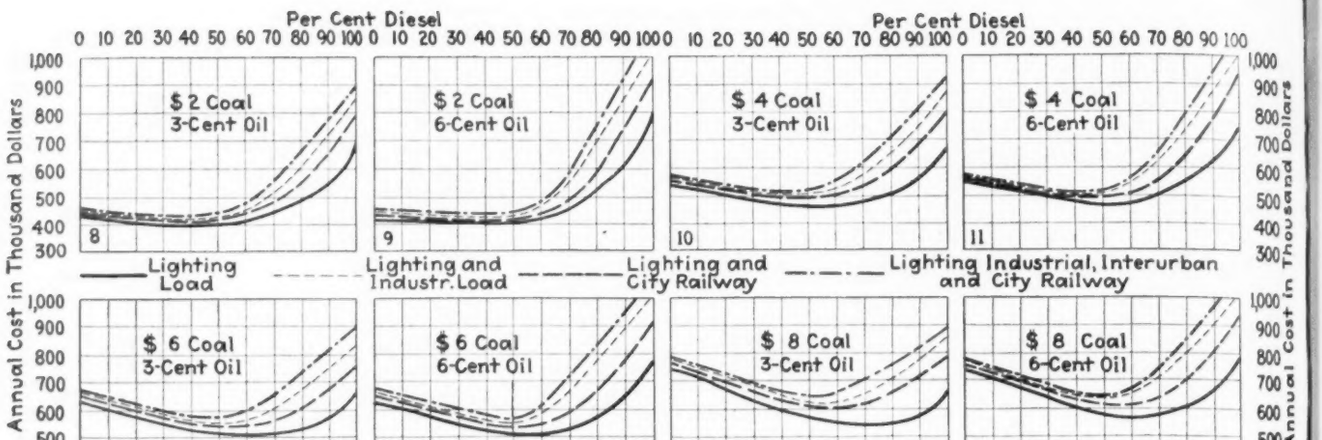


Fig. 7—Diesel and Steam-Generating Costs at Different Plant Capacity Factors (20,000 Kw.)

examining the shape of the curves in Fig. 7. It will be seen that the steam cost curves are very steep around 25 to 30 per cent capacity factor, which is the range where the stations usually operate. A small increase in

*"The Economic Field for Large Diesel Engines," a paper presented at the National Oil and Gas Power Conference, June 14-16, 1928, State College, Pa.


Per Cent Diesel
$ 2 Coal 3-Cent Oil
$ 2 Coal 6-Cent Oil
$ 4 Coal 3-Cent Oil
$ 4 Coal 6-Cent Oil
$ 6 Coal 3-Cent Oil
$ 6 Coal 6-Cent Oil
$ 8 Coal 3-Cent Oil
$ 8 Coal 6-Cent Oil
Annual Cost in Thousand Dollars
Lighting Load
Lighting and Industr. Load
Lighting and City Railway
Lighting Industrial, Interurban and City Railway
Per Cent Steam

Figs. 8 to 15—Generating Costs with Different Proportions of Steam and Diesel Capacity with Different Characters of Load

Based on 20,000-kw. plant with a maximum load of 14,800 kw. and 5,200 kw. standby. The difference between the left-end ordinate and the lowest ordinate represents the savings effected by combined operation.

capacity factor reduces the unit costs markedly. By cutting off the peaks of the "load mountain" we increase the capacity factor of the base load, and we save so much by doing so that we can afford profitably to spend more for the production of the peak energy. At any rate the peak energy is seldom more than 5 per cent of the total and its unit cost is almost irrelevant compared with the unit costs of the base load.

The important fact is that when carrying peak load by Diesel engines so much can be saved in steam costs that the saving more than pays for the Diesel power costs.

Savings by Combined Operation

The capacity factors of split central stations correspond to the load curves on page 1214, December 21 issue. Using steam turbines for base units and Diesel engines for peak units the actual production costs can be computed from these curves and Tables III and IV. The curves in Figs. 8 to 15 have been obtained in this manner. The savings have been tabulated in Table V.

Short-Line Calculations Easier with Direct-Reading Charts

By Elmer W. Johnson and H. E. Rhoades
Special Engineer and Assistant Office Engineer, Respectively, Northern States Power Company, Minneapolis, Minn.

In the study of plant increases and in the analysis of emergency conditions voltage distribution is highly important and the Northern States Power Company has found it to be essential to have a rapid means of determining the voltage drop on the 110-kv. lines between substations and on the transformer banks of the Minneapolis-St. Paul 86-mile loop. This loop is tapped by substations at eight points and may thus be considered as composed of short lines.

For this purpose direct-reading charts have been developed. For example, the sending-end voltage for one section may be read directly on one chart for any receiver

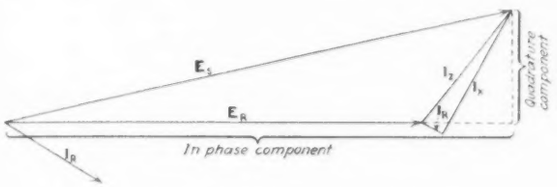
Table V—Savings Possible by Carrying Peak Loads on Diesel Units

Based on 20,000-kw. station with maximum load of 14,200 kw. and 5,800 kw. standby

Lighting Load, 34,000,000 Kw.-Hr. Annual Output; 24.0 Per Cent Annual Load Factor.								
Price of fuel	$2 coal 3-cent oil	$2 coal 6-cent oil	$4 coal 3-cent oil	$4 coal 6-cent oil	$6 coal 3-cent oil	$6 coal 6-cent oil	$8 coal 3-cent oil	$8 coal 6-cent oil
Capacity of Diesel peak unit	9,000 kw.	8,600 kw.	10,400 kw.	10,000 kw.	12,000 kw.	11,000 kw.	14,000 kw.	12,000 kw.
	45 per cent	43 per cent	52 per cent	50 per cent	60 per cent	55 per cent	70 per cent	60 per cent
Annual saving over pure steam operation	$31,000	$30,000	$81,000	$80,000	$125,000	$124,000	$180,000	$170,000
	7.3 per cent	7.1 per cent	15.3 per cent	15.1 per cent	19.8 per cent	19.7 per cent	24.5 per cent	23.0 per cent
Lighting and Industrial Load, 62,700,000 Kw.-Hr. Annual Output; 44.2 Per Cent Annual Load Factor.								
Price of fuel	$2 coal 3-cent oil	$2 coal 6-cent oil	$4 coal 3-cent oil	$4 coal 6-cent oil	$6 coal 3-cent oil	$6 coal 6-cent oil	$8 coal 3-cent oil	$8 coal 6-cent oil
Capacity of Diesel peak unit	8,000 kw.	8,000 kw.	9,500 kw.	8,500 kw.	10,500 kw.	9,500 kw.	10,600 kw.	10,000 kw.
	40 per cent	40 per cent	47.5 per cent	42.5 per cent	52.5 per cent	42.5 per cent	58.0 per cent	50.0 per cent
Annual saving over pure steam operation	$30,000	$30,000	$66,000	$62,000	$110,000	$105,000	$155,000	$145,000
	6.6 per cent	6.6 per cent	11.8 per cent	11.1 per cent	16.5 per cent	15.7 per cent	20.0 per cent	18.7 per cent
Lighting and City Railway, 39,600,000 Kw.-Hr. Annual Output; 39.3 Per Cent Annual Load Factor.								
Price of fuel	$2 coal 3-cent oil	$2 coal 6-cent oil	$4 coal 3-cent oil	$4 coal 6-cent oil	$6 coal 3-cent oil	$6 coal 6-cent oil	$8 coal 3-cent oil	$8 coal 6-cent oil
Capacity of Diesel peak unit	7,200 kw.	7,200 kw.	9,500 kw.	8,500 kw.	11,500 kw.	10,000 kw.	13,000 kw.	11,500 kw.
	37.0 per cent	37.0 per cent	47.5 per cent	42.5 per cent	57.5 per cent	50.0 per cent	65.0 per cent	57.5 per cent
Annual saving over pure steam operation	$30,000	$30,000	$72,000	$68,000	$110,000	$106,000	$155,000	$145,000
	6.8 per cent	6.8 per cent	13.0 per cent	12.3 per cent	16.6 per cent	16.1 per cent	20.4 per cent	19.0 per cent
Lighting, Industrial, Interurban and City Railway, 69,200,000 Kw.-Hr. Annual Output; 48.7 Per Cent Annual Load Factor.								
Price of fuel	$2 coal 3-cent oil	$2 coal 6-cent oil	$4 coal 3-cent oil	$4 coal 6-cent oil	$6 coal 3-cent oil	$6 coal 6-cent oil	$8 coal 3-cent oil	$8 coal 6-cent oil
Capacity of Diesel peak unit	7,500 kw.	7,500 kw.	9,000 kw.	9,000 kw.	10,000 kw.	10,000 kw.	10,500 kw.	10,500 kw.
	37.5 per cent	37.5 per cent	45.0 per cent	45.0 per cent	50.0 per cent	50.0 per cent	52.5 per cent	52.5 per cent
Annual saving over pure steam operation	$30,000	$30,000	$62,000	$62,000	$100,000	$100,000	$130,000	$130,000
	6.5 per cent	6.5 per cent	11.0 per cent	11.0 per cent	14.7 per cent	14.7 per cent	16.7 per cent	16.7 per cent

voltage at any given values of active power and reactive power. Or, from another chart the receiver voltage for the section may be read for any given value of sending-end voltage at any value of sending-end active power and reactive power. These charts may be considered as a modification and extension of the type of chart as described by Jones and Tompkins in their article in the ELECTRICAL WORLD of July 21, 1928.

The charts are based on the equation of the short line, capacitance being neglected. The quadrature component of sending voltage, receiver voltage being used as the reference vector, is also neglected. These two approximations give the limitations of the charts. The error involved can be readily calculated for any case. Neglecting the quadrature component gives the maximum error at the power factor that makes this quadrature component equal to the impedance drop. This would be unity power factor if the impedance were made up of reactance only and at leading power factors where the resistance drop forms an appreciable part of the impedance voltage. The charts are used almost entirely at lagging power factors. If the impedance drop be made up entirely of reactance and is equal to 10 per cent of the receiver voltage the error for unity power factor load



Vector Diagram for Short Transmission Line

will be one-half of 1 per cent; for 80 per cent lag it will be three-tenths of 1 per cent, and for zero power factor lag it will be zero per cent.

(The symbols in heavy type represent vectorial values.)

The voltage equation for the short line is: $\boldsymbol{E}_{SN} = \boldsymbol{E}_{RN} + \boldsymbol{I}_R Z$ for line to neutral voltage.

For line voltage it is $\dfrac{\boldsymbol{E}_S}{\sqrt{3}} = \dfrac{\boldsymbol{E}_R}{\sqrt{3}} + \boldsymbol{I}_R Z$.

Expressing I_R in term of its two components, the equation becomes

$$\frac{\boldsymbol{E}_S}{\sqrt{3}} = \frac{\boldsymbol{E}_R}{\sqrt{3}} + (I_{RP} + jI_{RQ})Z,$$

$$= \frac{\boldsymbol{E}_R}{\sqrt{3}} + \left(\frac{P_R}{\sqrt{3}\,E_R} + j\,\frac{Q_R}{\sqrt{3}\,E_R}\right) Z.$$

$$E_S = \left(E_R + \frac{P_R R - Q_R X}{E_R}\right) + j\,\frac{(P_R X + Q_R R)}{E_R}$$

If the quadrature component of E_S is neglected the numeral value becomes equal to the component in phase with E_R, hence,

$$E_S = E_R + \frac{P_R R - Q_R X}{E_R}$$

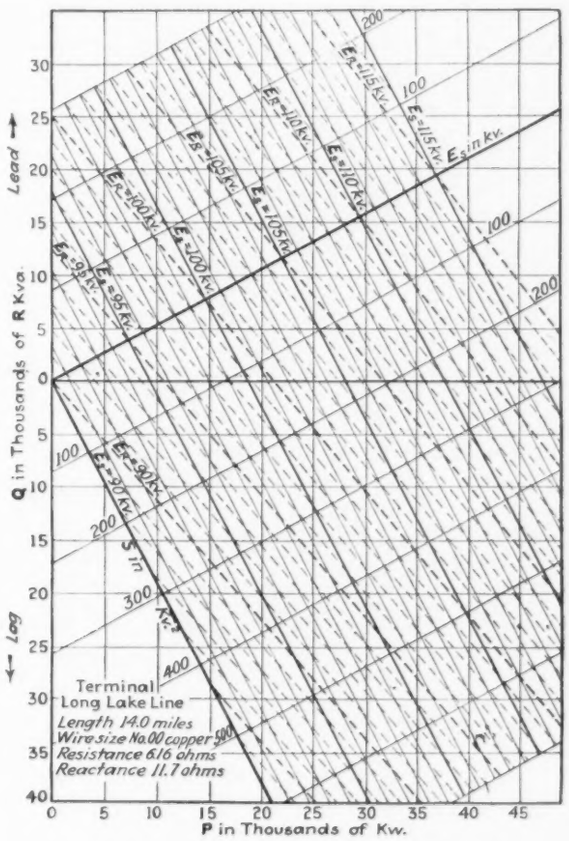
$$E_S E_R = E^2_R + P_R R - Q_R X$$

$$P_R R - Q_R X = E_S E_R - E^2_R$$

We wish to find values of P_R and Q_R for constant values of $E_S E_R - E^2_R$. Letting S equal these constant values the equation becomes $P_R R - Q_R X = S$.

This equation is plotted on co-ordinate axes of P_R and Q_R for different values of E_S. A series of parallel straight lines with a slope of $\dfrac{R}{X}$ is the result. These are plotted and the corresponding value of S marked on each line. At right angles to this S scale, a voltage scale is chosen such that the range of voltage required for the given case is covered. This then forms a new co-ordinate system, the axes being the S and E_S axes.

Now, if the equation $E_S E_R - E^2_R = S$ is plotted on the new axes for constant values of E_R the result is a series of straight lines. These are drawn in and marked with the particular values of E_R used. These straight lines will not be parallel because the numerical value of E_R enters into the slope, as can be seen by writing the equation in the form $E_S = \dfrac{S}{E_R} + E_R$. However, the change in slope will be small within the useful range of the charts.



Short-Line Chart for a Specific Line

Example: It is required to find E_S for the line given with E_R = 105 kv., P_R = 30,000 kw. and Q_R = 10,000 reactive-kilovolt-amperes lagging. The point on the S line is found which corresponds to the given values of P and Q. This value of S is not read, but the line of constant value is followed along the S axis to the place where it intersects with the line marked E = 105 kv. The value of E_S is now read direct on the E_S scale and is 107.9.

The charts may be drawn also for values of constant sending voltage with various values of P_S and Q_S in a similar manner to those for the receiver end.

The P and Q and the S scale will be exactly the same as in the chart for the receiver end. The difference can be best seen by comparing the equations between E and S for the two cases.

For the receiver end, $E_S = \dfrac{S}{E_R} + E_R$,

For the sending end, $E_R = -\dfrac{S}{E_S} + E_S$.

This shows that the slope of the line of constant send-

ing voltage for the sending-end chart will be negative as compared to the positive slope for the line of constant receiver voltage for the receiver chart.

These charts have been found to be exceedingly useful and well within the required accuracy. If they are drawn up in colored ink the lines are easier to follow. A convenient color scheme is blue cross-section paper for the P and Q axes, orange for the S axes, red for E_S axis and green for the lines of constant E_R. A chart of this type is very easy to read.

Standardization in Industry

Accomplished in electrical industry by co-ordination of manufacturers with each other and with recognized standardizing committees and societies

By B. A. Carstensen

Bryant Electric Company, Bridgeport, Conn.

THE term standardization is perhaps familiar to all of us, but is erroneously understood by a great many and therefore feared by some. Its possible results are looked upon with disfavor and suspicion by others who do not have an entirely clear conception of just what standardization is accomplishing and will further accomplish in industry in the future.

The ultimate purpose of standardization is to effect more economical production and distribution. By so doing it allows the manufacturer to bring the price of his product down to the price level of the greater majority of the people, so that they may not only benefit by being able to purchase the manufacturer's product but also, in turn, to increase the manufacturer's sales and corresponding profits on these products. A standard, then, which will accomplish the desired result must be very carefully set and often changed with changes in the art. The standard must be the best possible at the time or instead of a profit we shall realize a corresponding loss.

Standardization may include men, product, materials, parts, nomenclature, equipment and methods.

Standardization of Products

The standardization of products is accomplished by the co-ordination and co-operation of the manufacturers with each other and with recognized standardizing committees and societies. The least variety of similar devices which a manufacturer must produce to cover his line the larger the production becomes on each device, the larger the profit for the manufacturer and the lower the selling price to the industry. There are today in the United States, as well as in other countries, standardizing committees for nearly every class of business. It is the close co-ordination between the manufacturers and these committees which will effect the desired results.

There is another angle with regard to the standardization of products, as brought out by W. S. Rugg, vice-president of the Westinghouse Electric & Manufacturing Company, in a recent address before the National Electrical Manufacturers' Association. An extract form his remarks follows: "If electrical manufacturers in the United States are to maintain their place in the world market and at the same time maintain a scale of wages which will permit our present or an advanced standard of living, this must be done through an increased attention to the costs of production and distribution. To achieve this there must be a degree of standardization sufficient to maintain a given model until the expensive machinery necessary for its production in quantity may be justified." Mr. Rugg further explained that there should be a standard of performance besides standards of rating, dimensions and speeds. Regarding this standard of minimum performance for any product, Mr. Rugg cited the following benefits: (1) lower cost of manufacturing and distribution; (2) greatest adaptability to the purpose for which the apparatus is to be used; (3) greatest durability; (4) lowest cost of maintenance; (5) lowest cost of power for operating it.

Standardizing Materials

The decision as to the kind and type of raw material entering into the finished product of the company is a duty which should be assigned to one man or a committee whose work it shall be to see that the one best material suited for that individual job on which it is to be used is specified, and to confine these materials to as few a number as possible without impairing the quality of the product. The list of raw materials which manufacturing plants may produce is varied. Ordinarily we think of raw material as pig iron, steel billets, sheet metal, fiber tubing and the like. Nevertheless, to other manufacturers such articles as motors, switches, wire and gears are purchased as raw material. Raw material is that material which enters the factory as such and which later becomes a part of the ultimate product. We see, then, that often the finished product of one company is the raw material of another. Instead of ordering all of one kind of raw material from one buyer, it is generally agreed that it is better to spread the orders over a limited number, and this can be done only after exact specifications for the type of material have been determined.

Standardization of the component part which enter into the complete device presents an important problem. The greater the number of parts concerned the greater becomes the difficulty. The electrical and automotive industries in particular, manufacturing a very large number of parts, encounter this difficulty to a large degree, and therefore profit proportionately by their standardization methods. The principle of parts standardization is to use as few simple standard parts as possible. In plants using a large number of comparatively small parts the plan of keeping an up-to-date sample of each part on the display board is well worth while.

The display board is under the supervision of the engineering, purchasing or stores department, as the case may be to fit the requirements of the individual company. Perhaps the best of the three departments mentioned is the engineering division, since in nearly all cases it is here that all newly designed parts originate. Before designing a new part, then, the display board is first looked over very carefully to determine whether or not some existing part may not be used instead of designing a new part which would necessitate costly dies, molds or fixtures. As parts become no longer active because of change in design on the product, it is well to remove these to a separate display board on which only obsolete parts are shown. This is found to be very helpful, since the part, which at one time due to a change in design of the device on which it was originally used has become obsolete, may fit in with some new product brought out later. In some plants

where the parts are large and the plant has branch factories in various cities a display board showing each component part used by the company would be very cumbersome. In this case catalogs listing all standard parts, with necessary illustrations and dimensions issued by the main designing department to all subsidiary designing departments, are useful.

The nomenclature of parts and material is extremely important. All the departments should call the same thing by the same name and the nomenclature should be clear and concise, with sufficient but not superfluous description. The number of descriptive parts should be as limited as possible, but enough to give all interested parties adequate information. Most plants assign designating numbers or letters to parts and some plants assign the same to raw materials, these letters or numbers being arranged in a file in alphabetical or numerical order, as the case may be. A cross-index system of this file arranged to descriptive groups is often used to very good advantage.

Standardization of Equipment

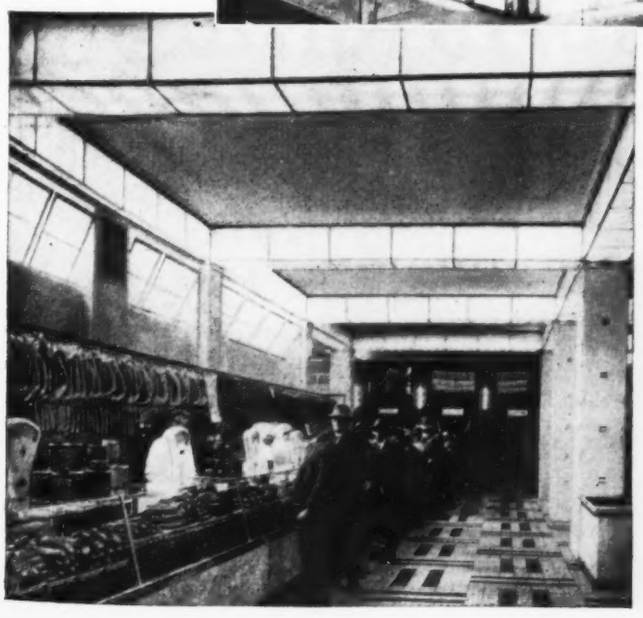
The standardization of equipment is one which will effect no mean saving. By equipment we include everything which performs some work either directly or indirectly upon the product or its component parts from the receipt of the raw material into the plant until the time it is shipped out of the plant in the form of the finished product. Some of the savings effected by standardizing equipment are as follows: (1) A smaller number of repair parts necessary to be carried in stock; (2) operators familiar with all machines of the same type; (3) auxiliary equipment standardized by standardizing machines on which it is to be used; (4) possible

Modern Lighting in Germany

The newly opened Karlstadt department store in Berlin, Germany, has followed up-to-date architectural lighting to a large extent. Electrical energy has been fully utilized for all applications, including cooking.

Channels with Frosted Glass Diffusers Supplemented by Neon-Mercury Tubes Are Used for Exterior Lighting

Large-Area Sources Brighten Food Department (below, left). Electric Sausage Making in Berlin Store (below, right)



discounts for purchasers in large quantities; (5) neater appearance.

Methods and processes may be divided into two main classes: (1) Those which enter directly into the manufacture of the product, and (2) those which enter indirectly into the manufacture of the product. The first group contains such items as dies, fixtures and jig design, assembly methods and conveyance systems. The second group contains such methods as storekeeping, employment work, rate setting and time keeping. The above methods and any others when standardized by all departments produce results well worth the cost of standardization.

Summing up briefly the advantages of standardization, then, we have the following: (1) It stabilizes production and therefore employment by permitting the manufacturer to stock his warehouses in the dull seasons and deplete them in active seasons, keeping a uniform production throughout the year; (2) it lowers unit cost by making mass production possible; (3) it lowers the customer's purchase price by lowering the unit cost to the manufacturer; (4) it quickens deliveries by allowing the manufacturer to stock standard products; (5) it promotes safety through the use of standard equipment which is familiar to all.

Street Lighting Costs Increase in Chicago

ACCORDING to the 32d annual report of the Department of Gas and Electricity of Chicago, it cost the taxpayers of that city $2.48 more per lamp unit to light their streets in 1928 than in 1927, although the increase in number of lamps—75,991 to 80,545—was 6 per cent. This appears to controvert the economic maxim of the reciprocal relation of volume and unit costs. The following table of unit costs, compiled from the reports for the two years, shows some striking differences in various items. The difference between the energy costs is not great, and it is easily accounted for by an increase of average lamp size. But farther down in the table one finds it rather hard to understand why it should cost 61 cents more per lamp for labor in renewals, cleaning and patrolling in 1928 than in 1927 on a system of such size. This is an increase of nearly 20 per cent. Aerial maintenance is a dollar per lamp in the later year. Operating overhead expense goes up $1.10. Also, there appears in 1928 an item unknown to 1927, "Administrative Overhead Expense," which is responsible for $2.19 added cost on every lamp in this city. There is about a dollar difference in the totals of "Estimated Additional Charges," which evidently indicates disproportionate growth of supply and service facilities.

Comparison of Street Lighting Costs for 1927 and 1928 in Chicago

	1927	1928
Average number of lamps	75,991	80,545
Operation and Maintenance		
Electrical energy	7.12	7.36
Substation expense	2.32	2.41
Incandescent lamps	1.85	1.55
Globes	1.04	1.22
Labor—renewals, cleaning and patrolling	3.57	4.18
Lamp fixture repairs	0.71	0.69
Transformer maintenance	0.90	0.82
Multi-conductor cable in conduit	0.23	0.33
Single-conductor lead-covered cable in conduit	0.78	0.62
5,000-volt steel taped cable	0.14	0.46
600-volt lead and jute covered cable	1.09	0.72
Conduit system	0.59	0.34
Lamp-post maintenance underground system	1.50	0.98
Aerial maintenance	3.27	1.16
City-owned automobile expense	0.94	1.35
Operating overhead expense	1.51	2.61
Administrative overhead expense	0.00	2.19
Cost per lamp	27.56	28.99
Estimated Additional Charges		
Ground rent	0.002	0.002
Office rent	0.06	0.06
Taxes	5.45	5.88
Depreciation	8.82	9.06
Interest	4.38	4.76
Legal and other services	0.02	0.02
Charges per lamp	18.73	19.78
Complete cost per lamp	**46.29**	**48.77**

Efficient Maintenance Truck for Low Cost

By R. J. Drake
Assistant Street Lighting Engineer
Public Service Company of Northern Illinois, Chicago

THE cost of the tower and platform mounted on the street-lighting maintenance truck shown in the accompanying illustration was $750. This is naturally exclusive of the truck and body. Inspection of the picture reveals that the tower has two controls, one for rotating it on the platform and the other for varying the angle of the upper section. The steps on this section and the working platform at the top are arranged in the design so that they maintain horizontal position irrespective of the angle of the section. This outfit, which is owned and operated by the A. A. Electric Company of Cicero, Ill., in the maintenance of an extensive system of ornamental street lighting in Berwyn, Ill., has proved itself to be an efficient tool.

220-Kv. Transmission

Paper before Tokyo conference deals with extra-high-voltage transmission problems and practice. Additional research needed for voltages in excess of 220 kv.

IN A paper* presented before the recent World Engineering Congress at Tokyo, Japan, design and operating problems of extra-high-voltage transmission systems (220 kv. and above) were discussed at some length. Authors of the paper showed that the many problems to be solved before 220-kv. transmission became a success had all been overcome and that the four American transmission systems now operating at this voltage were showing reliability equal to that of lower voltage lines.

The paper states that the performance of 220-kv. systems has been a great success and further sums up operating experience by saying: "No difficulties have been encountered that are not found in lower voltage systems. No radically different devices have been found necessary. The increased loads made possible by the higher voltage have approached the limit of synchronous stability of some of the longer lines. This situation has led to further study of this subject and better understanding now exists of this problem.

"High-Line" Service Affected by Birds

"Peak loads as high as 258,000 kva. have been handled day after day over one 220-kv. system. When these values are considered there can be no doubt as to the commercial success of transmission at extra high voltage. Some trouble from bird droppings and from large birds flying between the conductors and the tower have occurred in California. The former difficulty can be largely eliminated by bird guards which will keep the birds from roosting over the insulators, and the latter is an infrequent source of trouble. Insulation for 220 kv. is not proof against flashover by lightning, and each system has had some difficulty from this source. The value of ground wires seems to be fairly well established. Also, it seems fairly well established that a 220-kv. line is less subject to lightning trouble than a lower voltage line.

"There has been some trouble from vibration of conductors resulting in broken strands of the aluminum cable. In the case of one operating company this trouble seemed to be general throughout the 220-kv. lines, but appeared to be more pronounced when the conductor tension was quite high. The condition was remedied by vibration dampers which reduced the vibration to such an extent that no further trouble is anticipated.

"In regions where several months elapse between rains and where ocean fogs occur during the dry season some trouble is had from flashovers arising from dirty insulators becoming wet from the fogs. On lower voltage lines it is possible to overinsulate sufficiently to avoid flashovers between the rainy seasons. Not enough experience with 220 kv. has been had to show if the same plan is possible. The only satisfactory procedure at present is to establish a routine practice of cleaning insulators so as to keep dust accumulation down to a safe operating amount."

In reviewing the problems of design encountered when the first 220-kv. transmission was proposed authors of the paper list the following six major problems that had to be solved: (a) Insulation, (b) corona loss, (c) high charging current, (d) protection and switching, (e) system stability, and (f) lightning.

From laboratory tests and a study of insulation problems it was decided that the best insulation for 220 kv., using insulators commercially available, would be eleven standard 10-in. units on 6-in. centers for suspension and two thirteen-unit strings for dead-ends and strain positions. At the higher voltages and with long insulator strings the potential gradient becomes extremely high on the unit next to the line. The gradient across each unit was fairly well equalized by the use of metal shield rings attached to the conductor at the junction of the conductor and lower unit, or by the use of one or two special insulator units having slightly greater electrostatic capacity installed at the conductor end of the string.

On all 220-kv. lines consideration has been given to the behavior of the power arc when a string of insulators is flashed over. Hardware has been developed to divert the arc from the insulator string as far as possible so as to minimize insulator breakage from contact with the arc. Present practice is to provide a ring or horn at the tower end to function with the shielding ring at the conductor end of a string of insulators. In the latest type of high-voltage bushings for apparatus this protection also is utilized.

From available information it was believed that conductors for 220 kv. would have to be nearly 1 in. in diameter to avoid excess corona loss. Experience with the 220-kv. systems shows that the actual losses are not excessive with conductors of this size. Corona tests made on the 220-kv. lines of the Pacific Gas & Electric Company showed the influence of factors not considered heretofore. The data obtained clearly indicates the necessity of further research before conductors for still higher voltages can be selected with an assurance that the corona losses will be within economic limits.

High Charging Current

The charging current for high-voltage lines increases nearly in proportion to the voltage, hence the charging kilovolt-amperes increases nearly as the square of the voltage. For 200 miles of 60-cycle circuit about 50,000 kva. is required to charge the line. This immediately determines the amount of synchronous equipment that must be available to bring such a circuit up to voltage.

From the standpoint of quick and convenient operation not more than one generating unit, assisted by not more than one synchronous condenser, should be used to charge the longest section of line. With normal design a hydro-electric generator can supply about full load

*"*Extra-High-Voltage Transmission*," by *J. P. Jollyman, chief of division of hydro-electric and transmission engineering Pacific Gas & Electric Company, San Francisco, and E. R. Stauffacher, electrical protection engineer Southern California Edison Company, Los Angeles, Calif.*

charging current, while a synchronous condenser designed primarily to boost the voltage can supply only about 60 per cent of its rated capacity. For the circuit mentioned, a 55,000-kva. generator and a 20,000-kva. synchronous condenser are about the minimum-sized units that can be employed. A lower operating frequency reduces the charging kilovolt-amperes in direct proportion to the reduction in frequency. Even 100 miles of circuit at 50 cycles and 220 kv. would have a charging kva. of 21,000.

Generators and their excitation systems must be specially designed to carry heavy charging currents. Generator excitation must be very low, but must be stable, and these requirements impose conditions not otherwise encountered. A normally designed generator will not have sufficient synchronizing power to hold in step with the system if operated with its output delivered at a highly leading power factor. This characteristic makes it necessary to so design a high-voltage system that the generators will not have to carry appreciable charging current when carrying load. This result can be had by operating the generating end so that the charging current will be supplied from the receiving end. This condition relieves the synchronous condensers of supplying as much boost as would be required otherwise under a heavy delivered load, but may impose on them the duty of supplying additional charging current under light load conditions. After the first synchronous condenser station is passed the system may be operated at a constant voltage if conditions made this desirable.

Voltage Regulation

An important economic consideration in high-voltage, long-distance transmission is the cost of devices for providing satisfactory voltage regulation at the receiving end of the line. Economic considerations do not permit the voltage at the generating plants to be varied over any considerable range when load is being carried, nor may the generators be operated over any wide range of power factor. If voltage regulating devices are not employed the variation in voltage over a long high-voltage line under variations of load will exceed greatly the permissible variation of generator voltage.

Fortunately, the voltage drop depends upon the power factor of the load as well as upon the amount of load, and this fact permits the use of the synchronous condenser for correcting the power factor of the load current to a value which results in the desired voltage drop over the line. The cost of the synchronous condenser installation at the receiving substation must be regarded as a part of the cost of the transmission system.

Oil Circuit Breakers

Oil circuit breakers for 220-kv. service are the outgrowth of experience with lower voltage outdoor type breakers. Probably one of the outstanding problems was that of developing a suitable and rugged bushing. This, together with increasing the length of stroke and employing a larger and more rugged tank and developing a rugged operating mechanism, has resulted in an oil circuit breaker which has given quite satisfactory performance so far. The high cost of breakers has made necessary the use of the minimum number consistent with safe operating practice. When it is considered that a 220-kv. bus position costs about $100,000, it is evident that high-tension switching must be applied with considerable care.

The demands of 220-kv. operation require that the oil circuit breakers not only clear the fault from the system but accomplish this in the shortest possible time. The sooner the fault is cleared the less the possibility of a severe system disturbance and damage to lines and equipment. The short-circuit current which a 220-kv. oil circuit breaker may have to handle is enormous on large systems. The latest switches have an interrupting capacity of 2,500,000 kva., and it appears that system requirements may demand a 30 to 40 per cent increase over this rating.

The heavy operating mechanism, together with the long stroke necessary, does not permit as prompt an opening of the breaker as is desirable. About the minimum time obtainable at present is one-half second, whereas an operating time of four or five cycles would be more desirable. The maintenance required to keep oil circuit breakers in first-class condition results in a rather high operating cost unless duplicate or spare breakers are provided or protection is sacrificed when they are being serviced or repaired.

Relay Protection

Various types of protective relay schemes have been applied to 220-kv. lines. Power directional, ground or residual current directional, balanced or differential current, impedance, overcurrent, and combinations of these, all have been used, depending upon the conditions of single or multiple line operation. Due to the fact that apparatus for use on 220-kv. systems is quite expensive it has been found necessary in most cases to make use of bushing type current transformers mounted in the oil circuit breakers for the current element of relays. Where a source of potential is needed, this has been obtained usually from the low-voltage side of the power transformers. If relays are installed at a switching station where no transformers are available current relays only must be used, but this, of course, does not involve great difficulties.

During the past 5½ years of 220-kv. operation on one system there have been 148 cases of trouble and in all cases a flow of ground current was recorded. Even though the trouble resulted from widely varying causes, such as birds, fires, floods, lightning, sleet, contact with telephone wires and contact with trees, etc., ground current is always indicated. Accordingly, on one system the decision has been made to rely for protection solely upon residual or ground current relays. For single line operation, in cases where a line is removed from service for repairs, protection is provided for the line in service by means of ground directional relays, or, where no transformer bank is installed, by means of ground overcurrent relays. This simplification of the relay installation permits a duplicate set of relays at considerable saving in cost over the combined cost of phase and ground relays.

Ground directional relays have been applied on some systems and have a good performance record. Phase relays are retained on most systems, but many engineers are agreed that phase-to-ground protection is the most essential for 220-kv. operation. The protective scheme used on the latest 220-kv. lines depends upon the operation of impedance relays. Whatever type of relay is used, it is vital that it be absolutely selective and speedy in its operation. Present relays will hardly operate in a period of less than one-tenth of a second. From one-tenth to one-half a second may be sufficient in most cases, but if relays could be purchased and applied which would function reliably in one or two cycles they would be far

more valuable than the relays available at present, particularly from the standpoint of system stability.

System Stability

When considering system stability there are a number of factors to be taken into consideration:

1. The design of the generators and synchronous condensers is important. A high short-circuit ratio in the order of 1.5 to 1 or 2 to 1 is quite desirable. The characteristics of machines as regards stability during transient disturbances are determined by the leakage or transient reactance of the machine, assuming that the field flux is maintained substantially constant.

2. The use of quick response or super-excitation equipment so as to build up a voltage quickly across the field winding of a synchronous machine is necessary. By providing additional magnetomotive force to neutralize the demagnetizing action of the short-circuit current in the armature winding, and doing this in less than one second, there is less tendency for a system to become unstable than if excitation is applied at a slower rate.

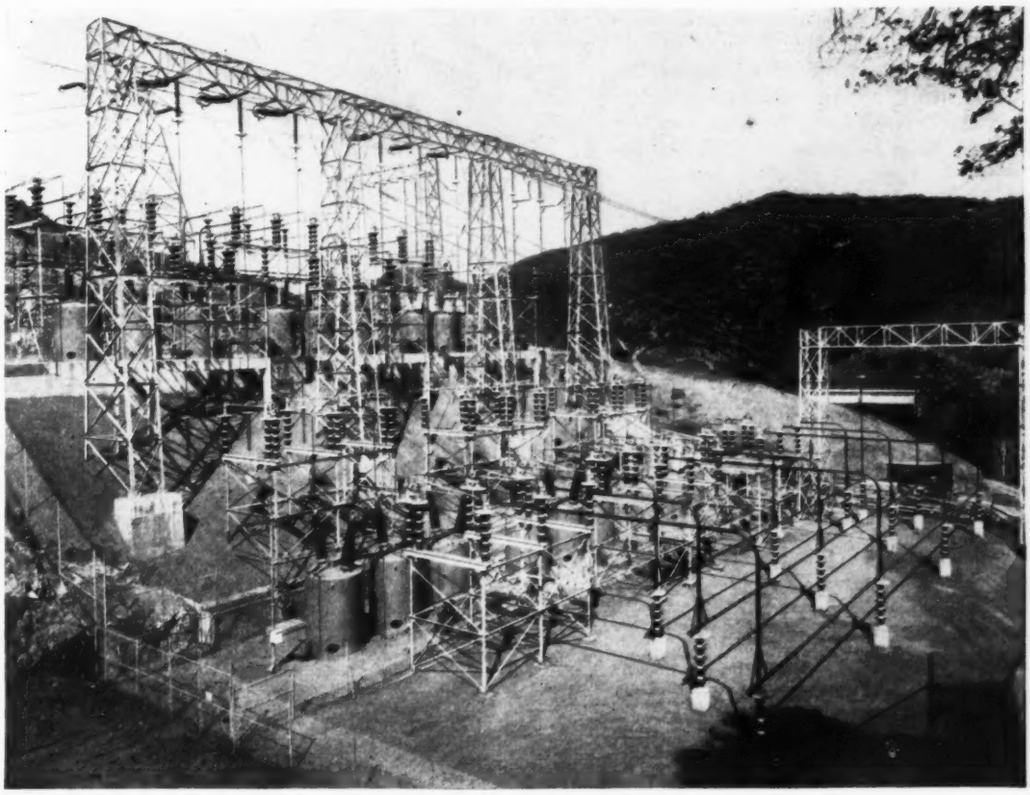
3. Some means momentarily to decrease the output of the generators at the sending end of a long transmission line at the time of a short circuit should decrease the tendency for the generators to get out of step. A device actuated by ground current and operating upon the waterwheel governors has been considered. Generators at the receiving end should be able to pick up momentarily most of the load so dropped so that the system frequency should not suffer to any great extent.

4. Probably the main factor in reducing disturbance and preventing loss of synchronism between the generating and receiving ends is the rapidity of operation of protective relays and oil circuit breakers. If the time could be materially reduced, for example to a value as low as one-quarter of the time now required, it is very probable that troubles could be successfully cleared while transmitting much greater amounts of power than at present without disturbance to the system.

5. The construction of 220-kv. lines is such that phase-to-ground faults predominate. It has been determined that the flow of ground current through the fault causes a heavy demand upon the transmission system due to the power consumed in the fault. For these reasons there has been an increasing tendency to consider the advantages of using some means of limiting ground current, such as a resistance or reactance in the neutral of some of the 220-kv. power banks.

The decision has been reached on one system that future transformers for 220-kv. operation shall either be provided with the neutral ends of the windings insulated for 73 kv., so that reactors or resistances may be used, or else that transformers shall be operated with neutrals ungrounded where there are adjacent grounded banks to maintain the system neutral. On lower voltage lines the Petersen coil has been widely used in Europe, and it may yet find more application on high-voltage lines both in Europe and America.

6. In the final analysis the stability of a transmission system is determined by the longest section of line which may be suddenly isolated from the system to clear a fault. If the power demand is such that the reduced transmission line capacity will not hold the generating and receiving ends in synchronism, it is obvious that



Distinctive Type of 220-Kv. Bus Used on One American System

Iron pipe bus supported by pedestal insulators eliminates overhead steelwork in this type of 220-kv. bus originated by the Southern California Edison Company.

instability will result. The excitation and regulating devices can only modify this situation within their limits, hence the power load must be kept down to a value which will give stable operation with the line capacity available after isolating a faulty section.

The Lightning Problem

When 200-kv. systems were first considered it was thought they might be nearly immune to effects of lightning, but operating records show that they are not entirely free from lightning trouble. However, they are undoubtedly superior in this respect to lower voltage lines. Recent investigations of lightning surges indicate that the highest lightning voltage exceeds the strength of any line insulation in use up to this time. Surges of more than 2,000,000 volts have been recorded and it appears that the only practicable way to handle such surges is by means of protective devices rather than by relying entirely upon the strength of insulation.

The failure of insulation of station apparatus is obviously more serious than the failure of the line insulation. There have been a few failures of 220-kv. power transformers as the result of repeated lightning surges. This indicates that the high-voltage stresses which may be encountered from lightning are much greater than was originally anticipated. It appears, therefore, that it is a matter of utmost importance to provide means of protecting the apparatus in the generating plant or substation. Owing to their high first cost, lightning arresters for 220 kv. have not been used extensively.

The most practicable means developed so far to lower the induced high-voltage surges from lightning is by means of one or more overhead ground wires mounted on the towers above the conductors. To realize the greatest benefit from overhead ground wires it is necessary that the tower footings be well grounded, and some engineers advocate that the overhead ground wire be made of material having as low electrical conductivity as consistent with the necessary mechanical strength. To obtain proper clearance between phases and from conductors to ground a 220-kv. line cannot be mounted very close to the earth, particularly where vertical construction is used. Accordingly as the induced voltage on a conductor from an adjacent lightning discharge is a function of the height of the conductor above ground it is quite important that some means, such as overhead ground wires, be used on 220-kv. lines if the line traverses a territory which is subject to lightning storms.

The greatest difficulty at present is to obtain a proper installation of the overhead ground wire so as to provide sufficient strength of attachment to the tower with a minimum possibility of breakage and adequate clearance from the conductors at all times. These considerations are not always so easy of attainment, for vibration of the ground wire may result in crystallization and ultimate breakage. Unequal sleet loadings of the conductors and the ground wire, coupled with different times of unloading, may result in contact between a conductor and the ground wire. Unequal wind loading due to the difference in area between the conductors and the ground wire, together with different stringing tensions, may result in different periods of swaying, which in a high wind may result in contact where a long span between towers is involved.

Existing Systems

The first 220-kv. operation was that of the Southern California Edison Company between the Big Creek hydro-electric plants and Los Angeles, which began May 6, 1923. This operation was over a distance of approximately 225 miles and consisted of the two original 150-kv. Big Creek lines remodeled and reinsulated for 220 kv. On November 16, 1923, the Pit River line of the Pacific Gas & Electric Company was placed in operation at 220 kv. Success of these operations led to the planning of other lines, and in 1928 the Conowingo project was placed in operation. Two single-circuit lines 58 miles ling connect the Conowingo hydro-electric plant with the Plymouth Meeting substation in Philadelphia. The synchronous condensers at Plymouth Meeting are noteworthy from the fact that at present they are installed almost entirely for the purpose of maintaining line stability at the time of transient disturbances. They are hardly necessary at present for line regulation, but their value for line stability has been well demonstrated. The Conowingo line is an illustration of the use of 220 kv. for transmitting a large amount of power for a relatively short distance. This 220-kv. project was followed by the Wallenpaupack line, placed in operation in 1929.

Most recent of the 220-kv. projects is the line of the Gatineau Power Company in Canada. This line is 230 miles long and connects the Paugan Falls plant with the system of the Hydro-Electric Power Commission of Ontario at Toronto. The accompanying table gives essential data on these five 220-kv. operations.

During the past few years there has been considerable activity in the design and installation of 220-kv. transmission lines in Germany. So far as is known, one 220-kv. line has recently been placed in operation. This line connects steam plants at Cologne, Coblenz, Mannheim and Württemberg to the Alpine power sources. Tower design differs somewhat from American practice in that towers are quite high in comparison to the base, almost assuming the proportions of a latticed steel pole. Static grading rings are used and fewer insulators are used than in American practice. The cap and pin insulators are longer, resulting in greater spacing between porcelain disks. Other European countries have not yet gone to this higher transmission voltage, but tentative projects are being considered in France and Russia.

220-Kv. Transmission Line Data

Company	Name of Line	Date of Operation	Length in Miles	Conductor	Insulation	Use of Ground Wire
Southern California Edison Co.	Big Creek	May 6, 1923	240	605,000 circ.mil. Al.	13 to 15, 10-in. units	Yes
Southern California Edison Co.	Vincent	1926	237	1,033,000 circ.mil Al.	13 to 15, 10-in. units	Yes
Pacific Gas & Electric Co.	Pit River	Nov. 16, 1923	202	500,000 circ.mil. Cu. 518,000 circ.mil Al.	13, 10-in. units 2, 13-in. units	None
Pennsylvania Electric Co	Conowingo	1928	58	795,000 circ.mil Al.	14, 10-in. units	Yes
Pennsylvania Power & Light Co.	Wallenpaupack	1929	45	795,000 circ.mil Al.	16, 10-in. units	Yes
Gatineau Power Co	Paugan Falls, Toronto	1928	230	795,000 circ.mil Al.		Yes

The economic capacity of a 220-kv., 50- or 60-cycle circuit is from 100,000 kw. to 200,000 kw., depending upon the length of transmission and other factors, such as the cost of power and the cost of the circuit. The economic capacity of a 330,000-kv., 50- or 60-cycle circuit is from 200,000 kw. to 400,000 kw. Few, if any, instances have yet appeared where the situation justifies intrusting such a large amount of power to a single circuit. However, such situations may arise and it is quite proper to inquire if such a transmission can be designed.

There is no doubt that transformers can be designed for such service. Many test transformers have been operated over long periods at voltages in excess of the 190 kv. to ground required for 330 kv. Oil circuit breakers can doubtless be constructed with insulation and with a total break suitable for this duty. An important problem will be to keep the speed of break sufficiently high.

Present knowledge of corona loss on conductors over 1 in. in diameter does not seem sufficient to justify the belief that conductors for voltages above 220 kv. can be chosen with any accurate knowledge of what the losses will be. Certainly further research in this subject is badly needed.

One of the subjects which received the most study when 220 kv. was first under consideration was the line insulation. It must be admitted that no radically new insulator unit was developed and that the ordinary suspension unit assembled in a longer string with or without some form of grading ring or arcing device has done very well. It does not seem at all certain that more of these units will equally well withstand a higher voltage. One of the problems is the matter of the distribution of voltage duty in the string when the units are wet, and especially when the units are dirty and wet. Observations of insulators on lower voltage lines indicate that the unit duty varies rapidly and widely with a tendency to flashover of units which dry first and take too much voltage. This might be a serious matter in very long strings at very high voltage.

Further research into the problems of extra-high-voltage transmission seems to be needed before present practice can be extended to any great extent.

Surveying Prospective Rural Business

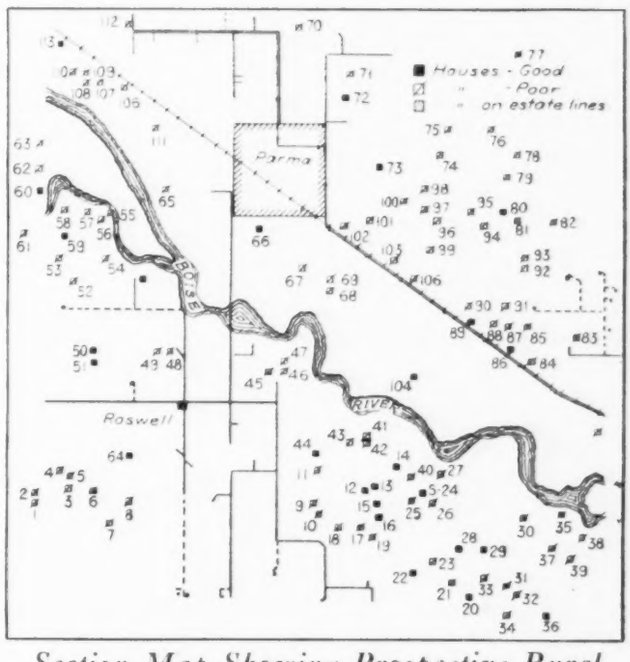
Maps showing potential business and data sheets furnishing a guide to prospective revenue found essential in laying out a rural electrification program

By T. A. Purton
Idaho Power Company, Boise, Idaho

WHERE a rural electrification program is to be embarked upon on a large scale and where an extension policy attractive to the farmer is in effect it is necessary to organize the effort to obtain quick results, save cost of construction and later operating costs. An important factor in such an undertaking is an accurate knowledge of how much business is available and how it lies with respect to existing lines. For this purpose a complete survey of the territory is necessary with the results presented in graphical form.

The final map should clearly indicate just where the good and lean business is, how best to organize to negotiate the business and when it should be solicited to fit in with the program of the construction crews. In other words, this should be a basic campaign map for the attack on the problem. Also such a map is basic for the engineering of the project.

In designing a rural system to be gradually spread out over a large farming district proper location of substations and trunk lines and correct choice of voltage and size of copper mean a great deal to the success of the undertaking. This is true because an improperly designed system means that about the time the rural lines become loaded and begin paying for themselves expensive reconstruction will be necessary. Simply to add one short extension upon another, like the branches of a tree, without thought to ultimate layout is fundamentally incorrect procedure. With the map resulting from the survey, however, a good ultimate plan can be determined upon so that all work done will fit into that plan. Also, engineers



Section Map Showing Prospective Rural Business and Probable Revenue

directing the construction crews find such a map of great value in handling the building of lines efficiently.

The survey made on the system of the Idaho Power

Rural Survey Indicates Load Values

Township—5-77 Range—5-W Parma—East. Date—2/5/'29

No.	Buildings: Good	Medium	Poor	Soil: Good	Fair	Hogs	Dairy	Poultry	Sheep	Silo	Irrig. Pumps	Misc. Power	Hay Cutting	Hay	Beans	Beets	Potatoes	Orchard	Grain
89	*			*		*	*							*					*
90		*		*		*	*							*					*
91		*		*			*							*					*
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Company has been carried on effectively by a three-man party traveling in an automobile. One of these men was familiar with distribution engineering and also had been engaged on the work of negotiating service contracts with farmers, so that he was generally able to judge quite accurately what revenue could be expected from a farm by looking over the premises and could also foresee construction difficulties in running lines. The distribution engineer belonging in the particular district surveyed was a member of the party and did the driving. The third man was an agricultural engineer and gathered data regarding possibilities of irrigation and drainage pumping and other apparent uses for power and also filled out an agricultural data sheet covering each farm. This party covered from 80 to 150 miles a day of country roads, running backward and forward on section and half-section lines. Short stops, scarcely more than momentary, were made opposite each farmhouse and the data recorded.

Records that Helped Analysis

To facilitate taking of data, two companion sheets were prepared. The first was an outline township map showing outstanding physical features, such as railroads, power lines, villages, towns, rivers, creeks, canals, etc. This allowed the surveyors to keep themselves located and upon the map the distribution engineer marked the location of each farmhouse with a number beside it. He marked each house with a symbol which showed the classification of the farm as regards revenue and whether it was a good or poor prospect for a service. Such a sheet is shown in the accompanying illustration.

The second sheet was used by the agricultural engineer to record his data, using numbers to tie in with the location of the farm on the township map.

These two sheets furnished the data for locating and classifying the farmhouses on a large general map of the district. They were filed in books and served later for reference in more detailed study by power and appliance salesmen.

Before the field survey was started the outlines of the general maps had been prepared. They were made to a scale of 1 in. to the mile and showed the main physical features as described for the small township maps. Since the prospective farm business of the Idaho Power Company lies largely on irrigated lands, the limits of this business were quite sharply marked by the edges of irrigation tracts. The barren country beyond the limits of irrigation were, therefore, indicated by a brown color on white prints of the map. The irrigated country was shown in dark green and proposed future irrigation tracts were shown in light green. This gave a clear picture of the country to be surveyed.

As the work of the survey proceeded the farmhouses were located and their classification indicated by symbols on the colored print. Any proposed drainage or irrigation pumping also was shown. Copies of the colored completed maps were then distributed to sales managers and division managers having charge of negotiating new business, to engineers having to do with design and layout of lines and to superintendents having charge of construction of lines. They are in daily use and have proved to be of inestimable value.

The cost of the entire work on the Idaho Power Company's system, comprising five divisions and covering more than 2,000 square miles of irrigated country, was estimated at $3,000. On account of all the work not being completed, it is not known yet whether the actual cost will reach or exceed this amount. However, the value of the maps so far completed is, no doubt, greater than the cost.

Energy Used by Appliances

THE accompanying table, compiled from various sources, gives working figures on the yearly energy consumption of various electrical appliances, as well as their wattage.

Averages depending on the habits of individual families are at best rough approximations. There are wide differences in the figures given by different observers, since no practical method exists whereby the consumption can be measured in a sufficiently large number of families to afford a reliable average. The table will, however, serve as a general guide to show how much load may be expected.

Approximate Consumption of Domestic Equipment

Appliance	Watts	Annual Kw.-Hr.
Clocks, electric	2	17
Clothes washers	250	240
Cookers	660	100
Dish washers	175	15
Egg cookers	450	
Exercisers	25	
Fans, ceiling		
Desk, 10-in	25	10
Desk, 12-in	55	
Exhaust, domestic	50	40
Heaters and radiators	600	40
Heating pads	60	18
Hot plates, grills	500	34
Ironing machines	1,100	125
Irons, 3-lb	330	72
6-lb	600	
Oil burners		200
Percolators	375	50
Radio sets		103
Ranges	5,000	1,500
Refrigerators, domestic	290	725
Sewing machines	25	10
Toasters	500	50
Vacuum cleaners	140	36
Violet ray outfits	30	1
Waffle irons	660	60
Portable lamps		80

Welding Power Plant Piping

Applications for which electric arc welding are specified. Time studies on welding operations in comparison with erection of flanged joints. Supplementary economy of pipe welding lies in ease of application of heat insulation

By C. I. GOUDEY

Construction Estimator Detroit Edison Company, Detroit, Mich.

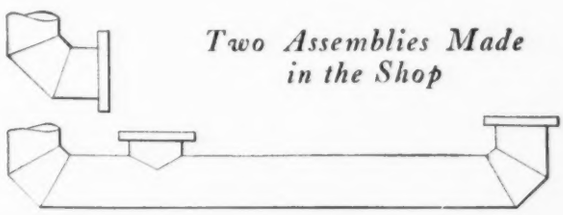
ELECTRIC arc welding of pipe lines is an accepted practice in the Detroit Edison Company for certain types of services. The applications for which it is specified were decided in a general design conference where various methods of constructing steam power stations and other system structures were analyzed. Based on relative physical merits and cost, the applications selected were:

1. Main heating header welding is to be done under extraordinary inspection. The taper on the ends of all piping must be gaged before it is welded. An inspection of the weld is to be made after the first beading operation as well as when it is finished.
2. Bleeder connections between the 12-in. heating headers and shut-off valves on bleeder lines.
3. All piping in condensate return pump pits.
4. Two-hundred-pound saturated steam headers between reducing stations and 12-in. heating headers.
5. Compressed air piping, including suction lines, headers and risers.
6. Exhaust lines of boiler feed pump turbines, general service pump turbines and 4,000-kw. direct-current unit exhaust, beyond the atmospheric relief valves to atmosphere.
7. Dry vacuum pump exhausts to canals.
8. All vents that are not under vacuum, except safety valves on boilers.
9. Steel soot removal piping from boilers.
10. Circulating water piping to and from auxiliary condensers.

Table I—Unit Quantities—Labor and Expended Material—for Welding Joints

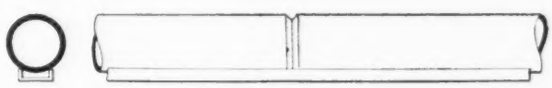
Size Pipe, Inches	½ to 2½	3	4	6	8	10	12
Cutting bevels—machinist, minutes	10	10	12	15	20	27	30
Mark with template—fitter, minutes	10	10	10	10	10	10	10
Torch bevel—welder and helper, minutes	10	10	10	15	18	20	20
Torch cut, minutes	10	10	10	15	18	20	20
Lining joint on ground—fitter two helpers, minutes	5	5	10	10	15	20	20
Spot or tack weld—welder, minutes	5	5	5	10	10	10	10
Welding butt-joint—welder, two helpers, minutes	15	20	25	30	40	55	70
Welding each ell joint—welder and two helpers, minutes	19	25	31	38	50	70	88
Welding tee joint—welder and two helpers, minutes	23	30	38	45	60	83	105
Cut, thread and flange—machinist and helper, minutes	10	10	15	20	24	32	40
Welding rod—butt joint, ounces	2	4	5	8	10	12	15
Welding rod—tee joint, ounces	3	6	8	12	15	18	23

Note: This compilation will serve as a base for a unit cost table by the applications of local factors of labor rates and price of welding rod. To be added are local costs for electricity — same periods as welding times — and for pipe fittings.



Two Assemblies Made in the Shop

These are branches from a 12-in. heating header, with flanges for valve connections. The ell is reduced from 12 in. at the header to 10 in. at the flange. The manifold is 12 in. throughout. The labor cost of the ell was that for a welder with one helper for 6½ hours; that of the manifold, was equal to 28 hours of the same rate.



As Better Methods Are Devised for Assembling Pipe Sections Economic Benefits of Welding Will Be Increased

One simple method for lining sections of straight pipe of the same size on the floor for tacking is to place them on a piece of channel iron.

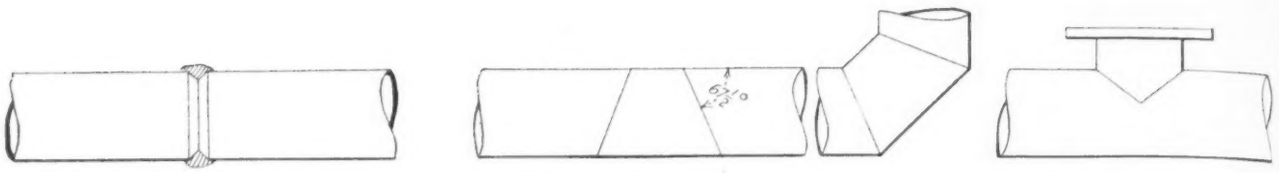
The decision to apply electric welding to pipe in the foregoing services was upheld by time and material cost studies in which comparison of welding operations with erection of flanged joints was made. The studies were made in meticulous detail on a large number of welding operations in compressed air lines, supplemented by corroboratory checks on pipe sizes not included in the air lines.

Records were made of the material which was used during the study and time checks were made on the following operations:

(1) Cutting, beveling and burring pipe in pipe machine; (2) lining up pipe on ground; (3) temporary hanging and lining pipe aloft; (4) tack welding pipe on ground; (5) tack welding pipe aloft; (6) marking pipe with template for tee or angle joints (this includes time to obtain and return template); (7) cutting bevel with torch; (8) welding pipe; (9) raising pipe, after welding on the ground, to its permanent location; (10) burning time of arc per unit length of weld.

The information obtained was analyzed and set up

Unit Comparisons of Welding and Flanging Applied to Three Types of Joints in 12-In. Pipe



Butt Joint

Welded

Cutting two bevels—machinist, minutes	60
Lining joint (on ground)—fitter, two helpers, minutes	20
Four spot or tack welds—welder, minutes	10
Welding—welder, two helpers, minutes	70
Electricity—time, minutes	70
Welding rod, lb.	1

Included in "cutting bevel" is the time taken to place the pipe in the machine, making cut, turning bevel, cleaning bevel and delivering pipe to welding location. "Lining joint" includes truing the pipe to line, also placing and removing clamps. Under "welding" is included the helper's time for turning or rolling the pipe for the welder.

Flanged

Using the table for flanged joints, the several operations will summarize as follows:

Cut, thread and flange two ends—machinist and helper, minutes	80
Placing gasket and bolting—fitter and helper, minutes	40

By using local rates for labor and adding costs of two companion flanges, one gasket and twelve bolts, this will show that although the labor cost of welding is higher than flanging, the added cost of the material in the flanged joint brings the total of the latter to over double the cost of the weld.

Ell Joint

Welded

For an ell joint, two cuts with a torch at an angle of 67½ deg. will produce the parts necessary to form a 45-deg. section in the joint. Insulation may be cut at a similar angle.

Marking with template — fitter and helper, minutes	20
Cutting with torch—welder and helper, minutes	20
Beveling with torch — welder and helper, minutes	40
Lining in place—fitter and two helpers, minutes	20
Tack welding—welder, minutes	20
Welding — welder and two helpers, minutes	140
Electricity time, minutes	140
Gas for cutting—time, minutes	30
Welding rod, lb.	2½

There seems to be a surplus of helpers' time on this job, but the table units used as a basis are not favoring the welding in the comparison.

Flanged

The cost of the flanged ell joint is shown thus:

Cut thread and flange two ends—machinist and helper, minutes	80
Placing two gaskets and bolting—fitter and helper, minutes	80
Two companion flanges	
Two gaskets	
Twenty-four bolts	
One flanged 90 deg. ell	

This shows the cost of the welded ell to be about one-third that of the flanged, obtained by applying local labor rates and adding local prices for two companion flanges, one flanged right angle ell, two gaskets and twenty-four bolts, again due to the material cost.

Tee Joint

Welded

With this assembly it is assumed that the lead from the header is to be connected by a flange as sketched. This will somewhat increase the cost over a straight welded job, but, perhaps, make a fairer comparison with a flanged tee.

Marking with template — fitter and helper, minutes	20
Burning—welder and helper, minutes	40
Lining joint—fitter and two helpers, minutes	20
Tack weld—welder, minutes	10
Welding — welder and two helpers, minutes	115
Cut thread and flange—machinist and two helpers, minutes	40
Electricity, minutes	120
Gas for cutting, minutes	40
Companion flange—local price	1
Welding rod, lb.	1½

Flanged

The analysis of the cost of the flanged tee joint summarizes thus:

Cut, thread and flange two ends—machinist and helper, minutes	80
Placing two gaskets and bolting—fitter and helper, minutes	80
Two companion flanges	
Two gaskets	
Twenty-four bolts	
One flanged tee	

The welded tee cost is slightly more than one-third the cost of the flanged job, which is obtained by applying local labor rates and adding local prices for two companion flanges, one flanged tee, two gaskets and twenty-four bolts.

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in tabular form like that shown in Tables I and II under the two headings—welding and flanging. Labor and material costs are not included in the tables presented here because of the variability of these items between companies and locations. Only time and quantity units are given, so any one who desires to obtain actual costs need only apply the unit labor and material costs existing locally. It is to be noted that the comparisons between welding and flanging here presented are based on floor or ground assembly. The cost of welding aloft is slightly higher due principally to the greater difficulty of lining up the pipe before tacking.

Although no money figures are included in the present data, the notes accompanying some of the details of joint types indicate that major economies were experienced with welding by the Detroit Edison Company. To these direct savings, possible also to others, there is to be added the reduction in costs brought about by the fact that welded piping, on account of the absence of flanges, is much easier to insulate. Labor and material for building up insulation around flanges is entirely eliminated. Further, the welded pipe line presents a neater appearance than a flanged one.

Table II—Unit Quantities—Labor—for Flanging Joints

Cut, thread and flange end—machinist and helper, minutes	10	10	15	20	24	32	40
Bolting joint—machinist and helper, minutes	..	..	27	27	27	40	40

Note: On this table may also be erected a table of unit costs by the application of local labor rates and the addition of local prices for companion flanges, ells tees, gaskets and bolts.

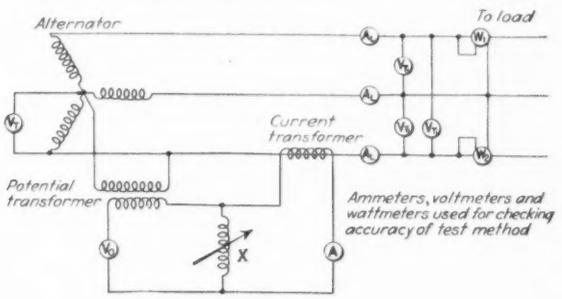
Synchronous Reactance Measured with Machine in Use

An accurate method is proposed for measuring synchronous reactance when A.I.E.E. or short-circuit methods cannot be applied

By L. Clifton Snively,
Boulder, Colo.

FREQUENTLY it may be desired to measure the synchronous reactance of an alternator for calculating its regulation for any given power factor and load, for determining its average power factor or the power factor for each phase or for the purpose of calculations in determining the stability of any transmission system. If the machine is in operation continuously, the usual methods of calculating its reactance by the A.I.E.E. or short-circuit methods are impossible. Hence, a comparatively recent method, mentioned to the writer by Prof. W. C. DuVall of the University of Colorado, by which measurements may be made while the machine is operating under actual load conditions will be of interest.

The principle is relatively simple. The reactance drop in one phase of the alternator is balanced by another reactance drop in which the line current is flowing in the opposite direction. This condition is obtained by connecting a potential transformer to one phase of the alternator with its low-voltage secondary connected through a low-reading ammeter and a low-reading voltmeter to the secondary of a current transformer in the line. A variable reactance X is connected across the secondary of the current transformer and the secondary loads are so brought out that the voltage V_o is higher than the phase voltage V_T; that is, after the transformer ratios have been taken into account. The accompanying diagram shows the connections used in this test. The variable reactance X consisted of a coil of many turns of No. 18 copper wire wound on a long fiber core. As an iron rod was moved into the core the reactance of the coil was raised.



Connections for Measuring Synchronous Reactance of an Alternator in Continuous Operation

In obtaining the synchronous reactance of an alternator the effective resistance is usually neglected, as it is very small in comparison with the synchronous reactance, and the same may be done in this method. The actual synchronous reactance is then found by varying X until the voltmeter reading V_o does not change appreciably with a change in the alternator load. If the resistance across the secondary of the current transformer is made equal to the effective resistance of the machine there should be no change in V_o. The variable reactance X need be changed but a few times, for one acquainted with alternators will know the approximate values of synchronous reactance, X_s, for the various alternator ratings.

Moreover, if the open circuit saturation curve is obtainable V_o is known and X may be adjusted so that the low-reading voltmeter will read this value. As soon as the variable reactance is so adjusted that V does not change, its value is measured by sending alternating current through it and measuring the voltage drop. Then the impedance is V/A, which is approximately equal to the inductive reactance X. Care must be taken to see that the iron core is operating on the straight part of its saturation curve, for if it is not, then the current used in obtaining the value of X must be the same as that in the test.

The following equations make the theory evident:

$V_o = V_T + IX.$
$V_T = E - IX_S.$
$V_o = E - I\,(X - X_S)$ — substituting for the value of V.
$V_o = E$ for any load when $X_S = X$

Where:

V_o = voltage as read by the voltmeter V_o.
V_T = terminal phase voltage.
I = line current.
E = induced phase voltage.
X_S = synchronous reactance of the alternator.
X = variable reactance.

Such are the equations when the transformer ratios have all been taken into account. The sole purpose of the ammeter A in the circuit is to calculate the actual current transformer ratio because any change in secondary impedance will materially change its ratio.

This method was actually employed by the writer at the University of Colorado with considerable success. The actual regulation of an alternator by loading it at unity power factor and then throwing its load off was 13.63 per cent; the regulation as obtained by calculation and using the synchronous reactance determined by the above method was 13.15 per cent. Two other methods gave regulations of 20.8 per cent and 6.67 per cent. Such actual data show the accuracy obtainable in using this new method for determining the synchronous reactance of an alternator.

Better Service to Banks

NUMEROUS refinements in electric service to banking establishments are coming to the front in the new quarters many of these institutions are opening to the public. As load builders some of these improvements amount to little except in the mighty aggregate of multitudinous small uses of service which smooth the pathway of modern business. Ornamental illumination is making great strides in this field, and the tendency to utilize subdued units in decorative schemes increases the connected load considerably in not a few banking houses. Branch banks in residential and semi-business districts are employing some very high-grade lighting equipment designs in their new homes, and in the utilitarian field of safe deposits, pilot lighting and signaling are doing much to enable such departments to serve customers more conveniently.

Automatic annunciator lamp signals actuated by the closing and opening of doors in coupon rooms are help-

ing departmental routine to check up the use of these premises before others enter, and baseboard lamps in these places are coming into vogue to aid the customer.

Letters from Our Readers

Economy of Buried Cable

To the Editor of the ELECTRICAL WORLD:

The article in the ELECTRICAL WORLD of October 19, 1929, on "Economy of Buried Cable," by F. E. Smith, suggests various points on which further enlightenment might be interesting. Surely a saving of 40 per cent in the use of armored cable in preference to conduit construction, if generally applicable, raises a question as to the wisdom of many installations.

From the figures given it would appear that the four routes open to the armored cables are approximately the same length, which is unusual. It is suggested that ordinarily the added length on account of four routes would be as much as the entire direct distance under consideration, namely, 3,600 ft. In that event, to use Mr. Smith's figures, the total cost of the armored cable would be about $135,000, as compared with $117,000 for the conduit installation. It is true that interest charges would favor the armored cable at first, but this becomes less as each additional cable is required, and finally when the installation is complete interest keeps piling up year after year in favor of the conduit installation.

Moreover, unless special steps are taken to prevent it, unequal length means unequal sharing of the load and resulting waste of capacity on the longer cables. The writer also believes that three-conductor, 500,000-circ.mil, P.I.L.C. cable can be installed for less than $3.27 a foot. It can be bought for $2.75, and 20 cents a foot should be ample for pulling in and jointing. Figures for the conduit installation would then become:

Conduit	$21,600.00
Cable installed	$21,594.00
Total	$43,194.00

Total installation (4 × 21,594.00) + $21,600.00 = $107,976

On the other hand, three-conductor, 350,000-circ.mil, P.I.L.C. and D.S.T.A. costs $2.35 per foot, which raises the cost of this installation to over $28,000, or, for eight cables, $113,000.

Other points in which Mr. Smith's figures are not clear to the writer are that he has apparently neglected the manholes in his armored cable costs, and also that the cost of repaving under this same heading (approximately $1 per lineal foot) does not seem consistent with an estimate of $6 per foot for nine-hole conduit over the same route.

Summing up briefly, then (1) the conduit installation costs appear too high and the armored cable installation costs appear too low relatively; (2) the usual case would involve added length because of using four routes, resulting in still greater cost for armored cables, unequal sharing of load, and waste of capacity on the longer lengths; (3) interest works in favor of armored cable at first, but later favors the conduit installation, and remains so ever after.

V. A. MCKILLOP,
Engineer.

Public Utilities Commission,
London, Canada.

Bonus Plan to Encourage Teamwork

To the Editor of the ELECTRICAL WORLD:

The increasingly liberal attitude of American business firms and corporations toward their employees, shown in part by the five-day week, semi-annual vacation, and especially by the various profit-sharing and bonus plans in use today, is a sign of the times. Tremendous strides have been made in the development and efficiency of machinery, but the awakening of the human element to greater expression has hardly begun. In human relations we deal with mind, not matter, and find that we cannot treat our workers as machines or as a market commodity and get the best results. In routine work there comes to be recognized a need for some kind of mental stimulus or expectation, to speed the work and to extend the ability of the worker. It is said the power of thought is the only real power man possesses, and as good engineers we should carefully consider all the forces entering into a structure.

So as thought, at some time or other, precedes all action, it is of prime importance that our employees be taught and encouraged to think rightly. The heart power of our men should be developed and efficiently used as well as the horsepower of our machines. For heart power is the mental motive force which brings out the best that is in people, increases the morale and the efficiency of the worker, arouses latent ability, makes for a wider co-operation, more intelligent interest in the work, and better discipline—all of which is self-expressed—a most desirable result.

The use of a portion of the surplus earnings to pay a bonus twice a year—before the summer vacation and before the Christmas holidays—has been shown to produce excellent results and proved to be not only a valuable incentive but also a bond of good will. When the iron bar becomes a magnet, all of the particles face in one direction and exert a united pull. So when the employees understand that their own good fortune depends on the good business results obtained, they become united in one common endeavor and work and plan for all kinds of improvements. The "man on the job" in his position of vantage regards the customer and the public from a more business-like viewpoint, feels a personal responsibility and a greater inclination for good work and good fellowship. Every one, in fact, is alert and awakened to watch the bonus, and not the clock. The inventive genius of the average American needs only the proper incentive to produce results in 1,001 ways, to improve methods, shorten work and save time and material and reduce errors.

Without any wage adjustments the bonus offers a natural means of securing the industrial co-operation and advantages so well spoken of by Edward J. Mehren before the Boston Chamber of Commerce, as published in *Christian Science Monitor,* Feb. 2, 1928. Mr. Mehren said in part: "More and more we are abandoning the theory of the 'living wage.' We believe in something more liberal, in what I call a 'security wage,' a wage that provides not merely a decent living, but enough margin to own a home, to educate the family and lay up savings." "An additional large advantage of having well-paid salary and wage earners is the industrial co-operation that results. Well-paid workers, under wise leadership, are ambitious, saving and contented and help reduce production costs. The combination of such workers, fair-minded capital and efficient management makes an impregnable industrial system.

ROGER S. WHITE.
Washington, D. C.

Digest of Foreign Literature

Hydro-Electric Development and Steam Equipment

Treatment of Sulphur Fumes.—Interim reports have been prepared by the special committee appointed by the Government Chemist on the question of the treatment of the sulphur fumes in connection with the operation of the London Power Company's (England) new Battersea power station. This discussion represents a condensed report of the findings of these advisers and various experimental tests to limit sulphur are reported upon. It is indicated that the requirements can be amply met in the controversy which is raised about this station, now under construction, both sulphur fumes and fly ash assuming considerable importance and both subjects have been touched upon in this report.—*Electrician (England)*, November 29, 1929.

Unsteady Jet Flow from Pelton Wheel Nozzles.—R. H. EVANS.—In order to obtain an estimate of the effect of an unsteady jet on the over-all efficiency of a Pelton wheel a gate valve was fixed immediately behind the nozzle. Various changes in the flow in order to give experimental information of a sufficiently diverse nature established performance curves for efficiencies and loss of head. It is indicated that a series of guides behind the needle parallel to the axis will eliminate any whirl in the water and reduce the amount of turbulence near the jet. A number of other specific conclusions were reached.—*Engineering (England)*, November 29, 1929.

Generation, Control, Switching and Protection

Turbo-Alternator of 50,000 Kw.—L. GUYON.—In the large steam power station of Gennevilliers, near Paris, supplying light and power for most of the Parisian demand, were installed until recently six turbo-generators of 40,000 kw. each, which proved inadequate to satisfy the rapidly growing demand. Two new units, each of 50,000 kw., were therefore added to the station. The machines are rated 42,000 kw. at 0.80 power factor, 6,000/6,400 volts, 50 cycles at 1,500 r.p.m. capable of 50,000 kw. for half an hour. The internal reactance of the generators has to limit the maximum short-circuit current to five times normal without the aid of external reactors. The manufacturer of these two new units had to meet the rather unusual requirement that the rotors of the machines must be interchangeable with those of the existing 40,000-kw. generators. The 24 steel disks of the rotor have 68 slots, of which 48 carry the pole windings, while the remaining twenty serve for ventilation. At 50,000 kw. an excitation of 660 amp. is required, which is derived from an outboard exciter. The complete rotor weighs 50 tons. The stator iron measures 9½ ft. in length and 5½ ft. bore diameter. Each of the 132 deep slots carries two copper conductors, which are composed of ten interlaced bars. The lower third of the slots (toward the rotor) is left empty to obtain the desired high reactance. Detailed description of the performance and the heat run tests on these generators with tabulated results and heating curves of rotor and stator are included.—*Revnue Générale de l'Electricité*, November 2, 1929.

Transmission, Substations and Distribution

Effect of Irregular Mechanical Load Upon Transmission Lines.—K. LANGHARD.—Complete and accurate mathematical information is available to calculate the maximum sag of a given line, suspended on chain type insulators under any given load, such as, for example, snow and sleet. But it is assumed that this additional load is uniformly distributed over the entire length of the line under consideration. No data have, it is said, been published previously covering the sag of a line, if only one or two spans have to carry excess load. The problem is presented in this paper, the author confining himself to load and sag curves obtained on a steel-aluminum cable of 0.325 sq.in. cross-section, weighing 1¾ lb. per yard, suspended on chains of 63-in. length. Further complications are introduced if the line extends over a rising or falling terrain.—*Elektrotechnische Zeitschrift*, November 14, 1929.

Heat Applications and Material Handling

Reduction of Shrinkage Cavities and Vacuum Melting.—W. J. P. ROHN.—The author has outlined a number of methods for reducing the shrinkage cavities in castings, and has paid particular attention to the possibilities of performing casting operations in a vacuum in order to secure a better quality of ingots. It is stated that the best method of avoiding shrinkage cavities absolutely is to carry on the process by electric heating. In this case a crucible is used, the shape of which corresponds with the shape of the ingot to be produced. The crucible is placed on a movable support which can be lowered after the melting process is completed. If the speed of lowering is suitably controlled the solidification of the liquid metal starts at the bottom end of the crucible and advances with the same speed as that at which the crucible comes down. The same method may be used if the metal is melted by high frequency induction. It is stated that the main advantage of the vacuum-melted metals and alloys is that the grade boundaries are nearly free from the slags and impurities. The process is particularly recommended for alloys ordinarily difficult to handle because of the large amount of scrap produced during the working. — *Engineering (England)*, October 18, 1929.

Electrophysics, Electrochemistry and Batteries

Properties of Sheet Magnetic Materials.—B. G. CHURCHER.—According to the author, an essential knowledge of the properties of sheet magnetic materials is necessary for the designer who wishes to secure the ultimate in satisfactory results. Accordingly an analysis of a number of factors, including permeability, effect of silicon content, hysteresis loss under alternating current magnetization and various mechanical and electrical properties allied thereto have been considered. A number of characteristic curves serve to coordinate the information for ready use. Special attention has been devoted to transformer cores experienced data adding to the analytical conclusions.—*Electrician (England)*, November 29, 1929.

Insulating Oils. — ALLAN MONKHOUSE.—The author has endeavored to present a comprehensive analysis of the various types of petroleum and asphaltic base mineral oils and their suitability for various dielectric and quenching purposes. Gas formation in oil switches has likewise been considered and a tabulated record of sludge tests, permissible sludge, viscosity, arrangement of such equipment, strength, flash point, evaporation, coal gas, specific gravity and other factors for various counties has been given. — *Electrician (England)*, November 29, 1929.

Miscellaneous

Bulk Supply of Electricity in Australia. — WALTER HAROLD MYERS. — A short statistical résumé of the relative magnitude of electric power supply in the various countries of the world and of corresponding data for the Australian States up to and including 1927. Particular emphasis is laid to the work of the Commonwealth Power Survey Committee of Australia in connection with the standards recommended for high-tension transmission, namely, 66,000 volts in that commonwealth. A number of other elements arising in connection with the generation of electricity have been included in this analysis.—*World Power (England)*, October, 1929.

News of the Industry

Upstate New York Battles the Elements

Niagara-Hudson System Now Emerging Victoriously from Prolonged Struggle with Sleet, Snow, Wind and Zero Temperature—Buffalo District the Hardest Hit

STAGGERING and in need of a chance to recuperate, but unbeaten and justly not a little proud of their herculean efforts to carry on, the public utilities of New York State emerged this week from more than eight days of some of the worst buffeting that Nature in her most perverse moods can inflict. Sleet, freezing rain, snow, high winds and zero temperatures came in repeated, prolonged and relentless doses. "The only thing that we need," said a power man whose organization had been working night and day, virtually without gaining on calamity, "is an earthquake." Even at that moment a fresh snowstorm was raging outside.

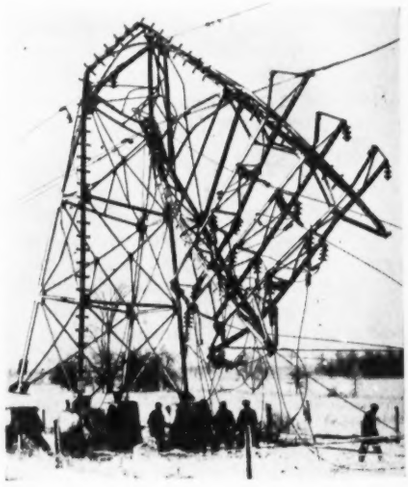
Starting on Monday evening, December 16, a comparatively warm rain fell in Buffalo and vicinity, where the temperature was, and had for some time been, below freezing. This rain, which finally became sleet, froze as it struck the cold wires, ground, trees, poles and towers, building up a thick, heavy layer of ice. Sleet and snow fell intermittently until Thursday night, December 19, when the temperature fell nearly to zero. On Friday a vicious 60-mile gale from the lakes turned loose the next discouragement. Snow fell at intervals thereafter, drifts as deep as eight feet in depth being common. It was much the same in other localities which awaited the onslaught from the west. The weather was, however, spotty in the extreme, some communities being struck hard and others escaping wholly or largely unscathed. Buffalo, Niagara Falls, Avon, Batavia, Olean, Glens Falls, Amsterdam and Saratoga were the hardest hit.

Transmission lines and heavy steel towers, distribution circuits on wooden poles, virtually every communication line, transportation facilities, railroads and trolleys all succumbed. Buffalo, divorced from the hydro-electric stations in Niagara Falls, carried for five days all its own power and light load, and that of Tonawanda and Fort Erie as well, on the Charles R. Huntley steam station. Peak loads of 226,000 kw. and 239,000 kw. were carried, although the nominal rating of this plant is but 225,000 kw.

Ordinarily about half of Buffalo's energy comes from Niagara Falls. Batavia, served by high-voltage lines from west and east, was without power or light for thirteen hours, and when through desperate efforts a breaker was found to hold for a single minute, the elements put forth fresh efforts at destruction, as if in malice, and the city remained in darkness for an additional 21 hours. Other communities in the western part of the state were similarly isolated beyond hope of early service restoration. Distribution facilities were badly impaired in the centers of fury, and line crews were almost wholly frustrated by the cumulative and continued character of the storm. Communication failures added to the difficulties. In the western end of New York the telephone company was reported to have ordered 30 carloads of wire and 60 carloads of poles for immediate delivery.

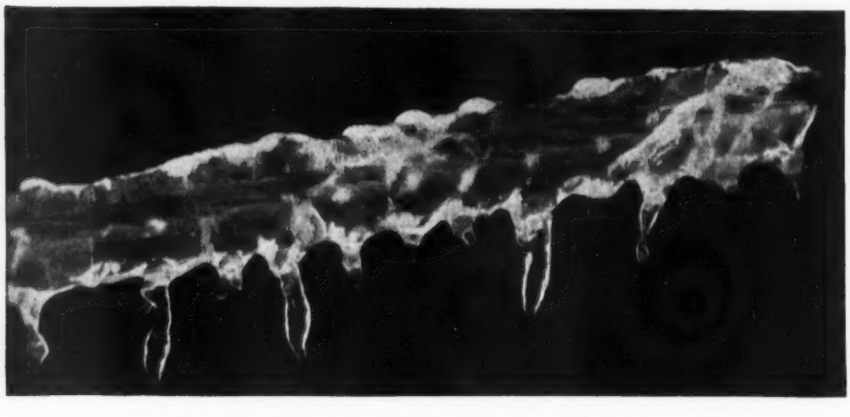
On the Buffalo, Niagara & Eastern Power Corporation's system fifteen great steel towers came down. Nine of these were on a line between Buffalo and Niagara Falls, throwing all but one of the several alternate routes for power supply connections into the discard. This remaining line was removed from service to melt the sleet by short-circuiting, in order to insure later service to other communities, since a continued use meant certain failure with ice forming in generous profusion. Application of 12,000 kw. cleared this line in an hour. Ice layers reached as much as $1\frac{5}{8}$ in. in thickness and averaged 1 in. in many cases. The weight of secondaries was estimated to have reached twenty to thirty times that under normal conditions.

In Buffalo 18,900 trouble calls were received in the three days previous to Saturday noon of last week, and by Sunday night service had been restored in every case. In spite of the terrible working conditions and highways so badly cluttered up that ten stops to the mile to clear fallen trees were often necessary, Buffalo reported that not a single lineman was injured and not a traffic accident was incurred by power-company trucks.



Long-Span Tower Near River Crossing Destroyed (B., N. & E.)

The Buffalo, Niagara & Eastern organized to fight the elements in every possible way. Planes flew over transmission lines to locate the breaks and were both successful and unsuccessful in doing so. Where success was achieved not hours but days were estimated to have been gained in territory otherwise inaccessible. Spare tower sections were rushed by truck and tractor to bridge the gaps caused by the wrenched twisting of suspension towers which fell, carrying adjacent ones to destruction. Interconnection ties were strengthened to carry the load from neighboring stations. The 30,000-kw. steam plant at Lyons, not ordinarily used at all, was quickly put on the line. The Salmon River hydro plant of 35,000 hp. contributed to the co-operation



Typical Sleet Formation (B., N. & E.)

offered to maintain service. But for the New York Power & Light and Northern New York Utilities ties, on the east, Syracuse would have been without service. On the south, the Penn Public Service, at Jamestown, arranged to shoulder an extra portion of the power man's burden from Wednesday on. "Snowmobiles," tractors, hired trucks, every available man, messengers in cars and on snowshoes were rushed to the defense. Men worked until exhausted, resting only at long intervals. Distribution lines were repaired as expediency dictated, there being no time to set poles except where absolutely necessary. Crews from unaffected or less seriously overwhelmed areas were rushed to the stricken areas. Sleet melting was applied to more than 150 miles of line.

The phenomenon of "dancing cables" was again encountered as the heavy wind of Friday whipped the sleet-covered cables up and down and made it impossible to keep lines otherwise intact in service. It is estimated that on some 600-ft. spans 500,000-circ.mil cables whipped fourteen feet. While service has been restored, there still remain weeks of work to place the transmission and distribution systems in their normal condition of system standards.

On the Eastern Front

Difficulties encountered by the Mohawk-Hudson organization were less severe than those confronting its ally, Buffalo, Niagara & Eastern, in that no transmission-line service was so badly hit. Distribution facilities were, however, in some sections completely wrecked. Trouble started at Saratoga at 6:30 p.m. Tuesday, December 17, and grew progressively more serious up to Thursday night as the sleet storm continued. By Wednesday no power left the Saratoga substation at all and the entire city was without service. In addition, Glens Falls, Ballston Spa, Hudson Falls, Fort Edward, Schuylerville and Greenwich were completely shut down. Fallen trees and ice-laden conductors constituted the difficulties. Many lines were cleared by removing the branches which had fallen upon them only to be thrown out of service in a few moments by fresh "shorts" as other trees collapsed. A heavy wind such as Buffalo and Genesee County encountered would, in the opinion of one operating man, have destroyed virtually the whole system, so heavy was the coating of ice. Calls for assistance were met by line crews from other towns, such as Albany, Troy, Utica and Schenectady, served by the Mohawk-Hudson system, as well as from their neighbor on the south, the Central Hudson Gas & Electric Corporation.

Here again communication failed the power companies both as to their private telephone lines and their public facilities. In order to carry out an important switching operation, communication between Rotterdam and Glens Falls, a distance of 40 miles, was established by means of a looped connection from Glens Falls to Montreal, to Cleveland, to New York City, to Albany, to Rotterdam, a probable 1,500 miles or more. Another attempt at communication involved the services of an amateur whose short-wave wireless set in Glens Falls was put in touch with another amateur's set in Cambridge, Mass.

By Wednesday afternoon distribution crews were being organized according to a definite and carefully laid-out plan, hospitals and city pumping stations to be taken care of first. More than one hundred extra men were on the job. Thursday, the worst of the storm, saw 225 more men at work. Crews were relieved for six or eight hours at the end of about twenty-four. One load dispatcher worked more than 60 hours.

Once Nature gave them a respite, the utility companies' efforts began to tell. By Saturday morning 35 per cent of the customers were being served. That night 50 per cent service was maintained. By Sunday night 75 to 90 per cent of the city and village customers were on the lines and a considerable number of the rural consumers.

A warm rain and rising temperature broke the back of the difficulty but undid much of the hard-earned restoration work, for the ice-freed branches rose under the conductors and, wet and soggy, caused new short-circuits.

Thus, in brief, did the electric light and power men of New York dig out of one of the worst storms experienced in that state in 50 years.

Maine Utilities Triumph Over Sleet

Service Is Crippled for Several Days, but Determined Efforts Relieve Situation—Portland Company's Loss May Exceed $500,000—Damage Elsewhere in New England

SERVICE was rapidly being restored to customers of the principal electric light and power companies of Maine on Sunday of this week, following one of the most disastrous ice storms ever experienced by public utility men in the Pine Tree State. The worst effects of the storm were felt by the Cumberland County Power & Light Company of Portland and by the great communication companies.

Fred D. Gordon, vice-president and general manager of the Cumberland County company, told the ELECTRICAL WORLD on Sunday that the damages to that system will probably exceed half a million dollars. Every transmission line entering Portland was out of service for several days, and the distribution systems fed from the company's substations were badly crippled all over its territory by falling trees and shattered limbs. The New England Telephone & Telegraph Company lost about two thousand poles. Telegraph service was almost annihilated for a time.

Fragmentary reports indicate that the Bangor Hydro-Electric Company sustained numerous interruptions of service but escaped the worst fury of the elements. The Central Maine Power Company suffered transmission-line failures in the upper northern areas and met considerable distribution trouble in the Kennebec and Androscoggin valleys, the restoration of service being greatly handicapped by lack of communication, but here as elsewhere a difficult situation was handled with skill, determination and unflagging energy. It was confidently believed that by Christmas Day electric light and power service in the principal cities and towns served would be over 80 per cent of normal.

The trouble in southern Maine began on Wednesday of last week, when sleet began to form, and after a slight let-up on Thursday ice accumulated with redoubled speed in the Portland territory. Thousands of trees were shattered as by shell fire and this was the major cause of line failure. At Portland linemen fought a losing battle until 2 o'clock Friday afternoon. At that time about 30,000 out of the 48,000 customers of the Cumberland County company were without service, although service was maintained successfully to many estab-

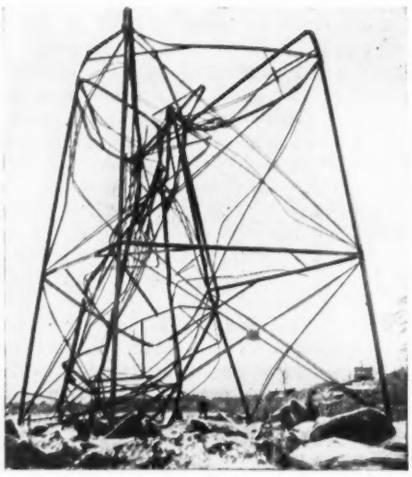
Heavy Ice Coat Fails to Destroy Corner Poles or Conductors (M.-H.)

lishments in the business center of Portland. The system load had fallen from 42,000 kw. to 7,000 kw. Only the 27,500-kva. Cape steam plant of the company, built some years ago to insure continuous adequate service to the Portland district in the event of transmission-line failure or low-water conditions at the interior hydro plants, saved the city from a disaster. By Saturday night this station was carrying 12,000 kw.

Outside aid was obtained at Portland from the Edison Electric Illuminating Company of Boston and the Central Maine Power Company. Twenty thousand of the cut-off customers were receiving service by Sunday night and the hospitals were all back on the line by Saturday. About two hundred poles were lost by the company, and in some cases distribution transformers were burned out by the short-circuiting of secondaries. Seventy-five per cent of the line trouble was attributed to falling trees or branches. About 1,500 out of 2,000 oil-burner residence installations were dead on Friday, but more than half of these were back on the line Sunday.

Sleet formation on the company's wires reached a maximum wire plus ice diameter of 3.5 in. The weight of ice and wire on the copper-clad 1,070-ft. span over the Saco River destroyed the 206-ft. steel towers at the Saco-Biddeford crossing of the 38,000-volt Portland-Biddeford line. These towers are being redesigned for replacement in 30 days. The newly built transmission line between the Bonny Eagle hydro plant and Biddeford was not injured, nor was the 38,000-volt line from the West Buxton hydro station. Until Sunday afternoon it was impossible, however, to utilize the new 66,000-volt tie line between the Central Maine and the Cumberland County systems.

On the Central Maine Power Company's system conditions grew bad with respect to sleet more gradually than at Portland. Main transmission lines suffered little except in the Newport area.



River-Crossing Towers at Biddeford Destroyed by Sleet

The Gulf Island-Farmingdale-Maxcy's to Rockland line was alive except for a momentary interruption. George S. Williams, vice-president and general manager, stated to the ELECTRICAL WORLD on Sunday at Augusta that the Central Maine company lost the equivalent of one day's output through interruptions and curtailed service due to tree troubles on local distribution systems.

SITUATION IN OTHER STATES

The New Hampshire Gas & Electric Company of Portsmouth escaped material damage, although about 30 per cent of the customers were without service following the sleet storm Wednesday. Service was restored within two days by line crews working day and night.

The New England Power Association lost some service on its distribution system at Gardner, Mass., and other points in northern Worcester County. The sleet-thawing schedule on high-tension lines in the Berkshire district worked perfectly.

2,300-Volt Pole Line Damaged in Portland

Storm Rages Also North of International Boundary

Furious storms, gales and extremely cold weather disrupted power service in many Ontario municipalities and played havoc with transmission lines across the province last week and this. Sixty or 70 poles between St. Thomas and Port Stanley were blown down and poles and wires in falling broke Hydro lines. As emergency crews of the Dominion Power & Transmission Company were overcoming serious trouble near Hamilton a high-voltage Hydro wire fell across the line at Allanburg, near Niagara Falls, cutting off several industries and interrupting service on the Hamilton Street Railway.

The city of North Bay, Ontario, is faced by the threat of a power shortage, occasioned by the freezing of many streams. The Hydro substation reserve water supply thus far available, at the present rate of consumption, will last three weeks. Unless a thaw sets in the city will be devoid of power at the end of this period. The power situation is also acute in Renfrew, causing much inconvenience to business.

The storm was also bad in Nova Scotia, part of the province being almost completely cut off for a while.

Indiana Gets a Taste of It

Heavy sleet and snow which swept Indiana on December 19 and 20 did thousands of dollars' damage to the electric utilities of the state. Service in some localities was entirely interrupted, but, generally speaking, the lines were kept in service. It will be some time before service is wholly restored and an estimate of the damage made.

Feelings Ruffled Over Power in Puget Sound Region

A little annoyance has manifested itself among municipal power suppliers in the Puget Sound region, recently threatened with a serious shortage in hydro-electric power due to the prolonged drought now apparently at an end. As told last week, the Tacoma municipal plant is now receiving 20,000 kw. a day from the U. S. N. airplane carrier *Lexington*. This energy is going exclusively to Tacoma, neither the Seattle municipal plant nor any private company being in need of assistance.

Seattle's attitude in the matter has displeased Tacoma's officials, and the latter city's Mayor and City Commissioners have by a unanimous vote decided that none of the *Lexington's* power shall be furnished Seattle except on a specific order by the Navy Department and that no power shall be sold to Seattle excepting such as otherwise would be wasted. For a number of years the two cities have had an agreement to exchange power. Whether the present situation will affect the continuance of this agreement remains to be seen.

Purchases and Mergers

New Bedford (Mass.) and Portland (Ore.) Transfers Consummated—Federal Light & Traction Control—To Bid for Dixie Power Company

IN ACCORDANCE with the agreement reported on October 5 (page 703), one of the oldest and best known utilities of New England joined the Associated Gas & Electric Company system December 20, when the New Bedford Gas & Edison Light Company was acquired by the New England Gas & Electric Association at $125 per voting trust share, 160,047 shares being transferred.

The Public Utility Holding Corporation of America announces that its contract with E. W. Clark & Company for the acquisition of the Portland (Ore.) Electric Power Company has been consummated. (See ELECTRICAL WORLD for September 28, page 654.) It is also reported in the press that the Public Utility Holding Corporation has purchased so substantial an interest in the Federal Light & Traction Company that it is now the dominant stockholder in that organization, which controls operating companies in New Mexico, Arizona, Arkansas, Washington, Wyoming, Colorado, Missouri and New Brunswick, Canada.

Several of the larger public utility corporations of the Middle West are understood to be figuring on bids for the properties of the Dixie Power Company of Cedar City, Utah, a unit of the W. B. Foshay system, following a conference between their representatives and the receivers of the Foshay enterprises.

The Ohio Public Utilities Commission has authorized the sale to the Ohio Electric Power Company, Sidney, of the Rockford Light & Power Company, the Ansonia Lighting Company and the Citizens' Light & Power Company, supplying more than a score of communities in northwest Ohio.

The People's Light & Power Company of New York was the only bidder on December 23 for the city-owned electric and gas properties of Danville, Va., which have been awaiting a large enough bidder. The People's Light & Power offered $3,750,000 and outlined through its president, C. E. Deal, a plan for building a hydro-electric station 70 miles from Danville. The Council deferred action till Monday.

The Pacific Gas & Electric Company has applied to the California Railroad Commission for authority to purchase for $123,000 and operate the electric properties of the Novato Utilities Company in the town of Novato and vicinity.

J. B. Campbell, Morton, Wash., owner of the electric light and power plant in that city, has sold his holdings to the Western Gas & Electric Company. He will continue as general manager.

Voters of Medicine Lodge, Kan., have decided to sell its electric plant to the Western Light & Power Corporation of Salina, Kan., for $140,000. Contrary decisions have been rendered by the citizens of Palco, Kan., asked to sell their transmission line and distribution system to the Kansas Power Company, and by the City Council of Elkhart, Kan., which has rejected an offer of $150,000 cash from the Kansas City Power & Light Company. A small private plant at Assaria has been sold to the United Power & Light Corporation of Abilene, Kan.

Petitions are before the New York Public Service Commission from the Massena Securities Corporation to acquire the outstanding capital stock of the St. Lawrence River Power Company and from the St. Lawrence County Utilities and the St. Lawrence River Power Company jointly for consent for the former to transfer to the latter a part of a franchise and system in Massena Township. No opposition to the petitions arose at recent hearings. All the companies concerned are subsidiaries of the Aluminum Company of America.

The Leverett (Mass.) Electric Company, which purchases all its energy from the Amherst (Mass.) Gas Company and recently applied for permission to purchase the electric property of the latter, has arranged for the transfer of its property to the Western Massachusetts Companies. The Western Massachusetts Companies control the East Hampton Lighting & Power Company and the Amherst Gas Company, both of which have petitioned the Public Utilities Department for authority to separate their gas and electric departments. It is then planned to combine the electric businesses of the East Hampton, Amherst and Leverett companies and to operate them as the Western Counties Electric Company.

The Duke Power Company has bought the Lake Tahoma power plant, near Marion, N. C., and the power plant at Old Fort, N. C., according to announcement by J. G. Gilkey of Marion. The Lake Tahoma plant has been owned by the Lake Tahoma Company of Marion, the power being sold to the National Utilities Company, which furnishes power there. The Old Fort plant has been owned by the Jupolo Service Company of Cleveland, Ohio.

By reversing a decision of a lower court preventing the South Georgia Power Company from operating in Nashville, Ga., the Georgia Supreme Court has upset the purchase a year ago of the municipal lighting system of Nashville by R. C. Beaumann and R. C. Burrus for the sum of $52,000.

Seventeen Electric Leagues Specially Approved

At a recent joint meeting of the League Council and the league and field advisory committee of the Society for Electrical Development R. Bourke Corcoran, chairman of the League Council, reported that certificates of approval will be given to the leagues operating in Denver, Boston, Binghamton, Salt Lake City, Kansas City, St. Louis, Rock Island, Erie, Rockford, Youngstown, Cincinnati, Chicago, Cleveland and Albany and that organizations in Philadelphia, Indianapolis and Pittsburgh will undoubtedly receive them. Approval means that letters will be sent out from the N.E.M.A. and the League Council asking manufacturers to give serious consideration, to extending financial support to these leagues.

The midwinter conference business program was discussed in detail, and it was decided to make the high spot of the conference an "all-industry day" at which leaders of various branches of the industry will address the conferees on matters of special interest at the moment. This conference, as already announced, will be held at the Westinghouse Lighting Institute, January 13-16, inclusive.

Planning Development of Cheat River

West Penn Electric Sees Eventual Output of 660,000 Hp. in West Virginia —Two 58,000-Hp. Plants to Be Built First

THE West Virginia Power & Transportation Company, a subsidiary of the West Penn Electric Company, filed application on December 20 with the Public Service Commission of West Virginia for authority to engage in an extensive water-power development along the Cheat River watershed in five counties of northern and central West Virginia. The commission set February 11 for a hearing. Fourteen projects are listed in the company's application, designated as near Morgantown, Kingwood, Albright, Bruceton Mills, Rowlesburg, St. George, Parsons, Hendricks, Davis, Thomas and Elkins. A portion of a storage reservoir in Big Sandy River would be in Pennsylvania. Estimated capacity of the proposed hydroelectric plants is fixed by the applicant company at "in excess of 600,000 hp.," and it is added in the application that the developments will require, as a condition precedent to their construction and operation, a steam-electric generating system to carry the base load, with a total generating capacity of approximately twice the capacity of the water-power development.

The first construction planned is a storage dam, 78 ft. high, on Blackwater River. This, company engineers estimate, could be constructed within ten months. Six months after construction of the storage dam, the application says, the company will begin construction on the Blackwater of a diversion dam, 55 ft. high, to divert water through tunnels or conduits to a power house having a capacity of 58,000 hp. A third project planned on the Blackwater is a diversion dam, 98 ft. high, to send water through tunnels to a second power house of 58,000 hp. capacity. Construction is to be started one year after the first diversion dam is completed. Each of the diversion dams could be constructed in one and one-half years. A tentative construction date also is fixed for a project at Beaver Hole consisting of a dam 106 ft. high and a power house with a capacity of 86,000 hp. Construction will be started there, the application says, two and one-half years after the final Blackwater project is completed and is expected to require two years.

The company declares itself "unable now to predict with any confidence the time and sequence in which the remaining developments shall be constructed." Six of these are in Preston County and three in Randolph County, all of them being outlined in the application. There is also an undefined development contemplated for Shavers Fork.

An exhibit filed with the application makes an estimate of $17,000,000 as the cost of the four projects proposed for completion within a nine-year period, if the commission approves the application.

Coming Years Loom Large in Dominion

Ontario Hydro Undertakings Involve Nearly $40,000,000—*British Columbia Envisages* 1,000,000 *Hp.—Activity in Nova Scotia and in Manitoba*

ANY summary of the program of the Ontario Hydro-Electric Power Commission for 1930-31 is impressive. It calls for new power development and an extension of transmission lines that promise to have an important bearing on the industries of the province. Among these developments are the Chats Falls undertaking, on the Ottawa River, of 200,000 hp., which will cost nearly $17,000,000, and the development of Alexandria Falls on the Nipissing River, bringing in 54,000 hp., which will be completed late in 1930, at an expenditure of approximately $8,000,000. The duplication of the Gatineau Power Company's transmission line and transformers, recently noted, will entail an expenditure of nearly $4,000,000, and the extension of rural lines throughout the province will consist of approximately 1,200 miles covering an outlay of between $4,000,000 and $5,000,000. The commission will soon complete the tenth unit of its Niagara development, at an outlay of $4,000,000.

The various undertakings involve an expenditure of close to $40,000,000 and will release for the people of the province about 680,000 hp. within the next few years.

The latest estimate of the ultimate cost of hydro-electric development projects under way in British Columbia is $110,000,000. From these schemes power companies will eventually obtain 946,000 hp., or almost twice the present output of the province. In 1914 the total output was only 64,474 hp. The ambitious projects are actually authorized by the Water Board, and it is estimated that an equal sum of money will be invested in enterprises to consume the additional power.

The Nova Scotia Power Commission has virtually completed work upon the Mersey River power developments which will supply the electrical energy for the Mersey Paper Company's new mill near Liverpool, N. S. Complete installation of six generators will be ready in advance of the opening of the mill. These are at three sites which have been harnessed together for the development of an aggregate of 31,000 hp. The power houses are at Upper Lake Falls, Lower Lake Falls and Big Falls and have been constructed by the Foundation Company of Canada. The entire project has involved a capital investment of $3,700,000.

Beginning of the coal-shipping season next spring in Nova Scotia will also mark the end of steam as a means of power in the mines of the British Empire Steel Corporation, and in the not far distant future all mines of the corporation will be operated entirely by electricity. This will mean a very large outlay of money on the part of the corporation, starting with the new million-dollar power plant now under construction on the shores of Glace Bay Lake. Already the corporation has linked up its power plants on the southern side of Sydney Harbor, a high power line extending from the Sydney steel plant to the power plant of the Dominion Coal Company at New Aberdeen, and there is also the line that connects up the Carney Lake power plant on the outskirts of New Waterford with the plant at New Aberdeen. The final link is under way, and this will connect the Sydney plant with the workings at Sydney Mines, the high-voltage line being run in a submarine cable across the entrance to Sydney Harbor.

The provincial Hydro system in Manitoba is planning to widen its scope of activities during the coming year. In addition to the ever-increasing industrial demand in the Greater Winnipeg area, the publicly owned system, which has a contract for electrical energy with the Manitoba Power Company, has power agreements under consideration at many points in southern and western Manitoba. Coincident with its proposed westerly extensions the provincial Hydro may invade the city of Brandon, where negotiations have been in progress for some time with the municipality and the Canada Gas & Electric Company, which now holds the franchise. The summer resorts on Lake Winnipeg may also be invaded by the provincial Hydro next spring.

Carlisle for Disinterested St. Lawrence Inquiry

Chairman Niagara-Hudson Power Explains Company's Position to New York Investigating Commission—Buffalo Man Assails Regulatory Body

FLOYD L. CARLISLE, chairman of the board of directors of the Niagara-Hudson Power Corporation, testifying at Buffalo and Syracuse last week before the legislative commission for the revision of the New York Public Service Commission law, declared that he was in favor of a "disinterested investigation" of the whole problem of harnessing the water power of the St. Lawrence River. In a prepared statement Mr. Carlisle said:

By reason of the geographical location of the operating companies of the system and the ownership of the riparian rights of the Frontier Corporation upon the Long Sault Rapids on the St. Lawrence River the company desires to state very fully and frankly its position regarding this development. It is not my intention to discuss the legal position of the various parties interested other than to say that we would welcome a judicial determination upon these rights so that no shadow of doubt could remain as to the position of the various governments and private interests involved.

The development of the Long Sault Rapids for power purposes will constitute the largest single hydro development yet made and probably possible to make in the world, and it possesses unusual and extraordinary hazardous engineering and construction problems. The previous owners of the Frontier Corporation were prepared to proceed with the development without government aid and entirely with private capital.

The ownership of the land under water from the shore line to the international border is in the State of New York, although the rights to the use of the water for power purposes are in the owner of the banks. The federal government, by reason of its control of navigation, has certain interests. The Dominion of Canada and the Province of Ontario possess rights analogous to those of the respective governments on this side of the border. In recent years no progress has been made toward the development of power.

We are desirous of determining the difference existing and moving the development forward. The company welcomes a thorough study and disinterested investigation of the whole problem and will favor whatever sound, economic plan will result in the sale of electricity to the consumer at the lowest rates and with the maximum benefit to the industrial life of the state. To this end, with open minds and with a whole-hearted desire to cooperate, we favor such a study of the whole problem.

Mr. Carlisle, asked to suggest changes to improve the law, expressed his belief that the decisions of the federal courts under the Fourteenth Amendment were the determining factor in rate making.

Another witness before the commission at Buffalo was Frank Perkins, president of the City Council. Mr. Perkins said that Buffalo had spent $206,090 in attempts to lower rates since the Public Service Commission was formed. Local utilities, he said, had in the same time spent $1,000,000 to defeat such attempts. This expense, he charged, has been passed on to the consumers. In appearing before the commission, Mr. Perkins declared, the consumers were "playing against loaded dice and stacked cards."

Joseph T. McCaffrey, Oswego corporation counsel, as chairman of a special committee of the Mayors' Conference, an association of municipal officials, declared at Syracuse the belief of this body that property values reported by public utilities for tax purposes should be presumptive evidence of the value of the same properties for rate-making purposes.

Public Service Commissioner Neal Brewster was on the stand, asking for a larger staff of accountants, when the investigators adjourned to meet again in New York on January 2.

Chairman Attwill Testifies at Legislative Inquiry

Chairman H. C. Attwill of the Massachusetts Department of Public Utilities appeared before the Massachusetts legislative recess commission appointed to investigate the public utilities situation last week. He expressed the opinion that so far as possible utilities should be privately owned and operated. If, however, the public could be shown to suffer because of such operation and ownership, then he would favor regional public ownership rather than municipal. He favored the publication of public utility reports.

Another Section of Scottish Grid Scheme Opened

Another section of the main transmission lines constructed in Scotland by the Central Electricity Board has been energized, and as a result the important Greenock area is now within the active grid system. This section of the grid links up Greenock with the large power station at Yoker, Glasgow, of the Clyde Valley Electrical Company. The transmission lines cross the Clyde at Yoker by suspension from two towers so high that there is no possibility of any interference with shipping, and then pass through open country by way of Bridge of Weir and Kilmalcolm to Greenock. A length of nearly 50 miles of transmission cables is now in use in central Scotland, including the sections between Bonnybridge and the Glasgow Corporation's power station at Dalmarnock, between Delmarnock and Yoker and between Yoker and Greenock. On the Yoker-Greenock line, which is 18 miles in length, the voltage is 132,000, as on the other sections.

The next stage in the central Scotland scheme will be the linking up of Bonnybridge and Portobello (where the corporation of Edinburgh has a large new power station) and the completion of the loop to Kilmarnock and Saltcoats and back to Greenock. Meanwhile the authorities concerned are carrying out the extensive work of altering their plant so as to make it conform with the standardized frequency of 50 cycles. Glasgow has completed all the operations required in its Govan area, which represents a load of 16,000 kw. at 50 cycles, and the Clyde Valley Company is changing over the Yoker area.

More About Spier Falls (N.Y.) Plant Enlargement

An official account of the coming installation of a 57,000-hp. generator at the Spier Falls plant of the New York Power & Light Corporation, already referred to in these columns, says that the unit, which will increase generating facilities to twice their present capacity, will be completed in December of next year. It will make the Spier Falls plant the largest hydro-electric station in the state, apart from Niagara Falls, according to a statement by the company. Completion of the Conklingville hydro-electric plant of 32,000 hp. rating, located below the dam of the Hudson River Regulating District on the Sacandaga River, added to Spier Falls, will give the Mohawk-Hudson system a generating capacity of about 550,000 hp. Power from both the Spier Falls and the Conklingville station will be taken into the general transmission system of the New York Power & Light Corporation and will be available to all parts of the territory.

The new generator will be of General Electric manufacture. To house it a section of the building has been torn down and will be rebuilt higher and of greater dimensions. Enlargement of the forebay is already in progress. The plans also provide for the enlargement of the headgates at the water intake and the installation of mechanically operated gates in place of the flashboards previously used on the dam. The construction work is being done by Stevens & Wood, engineers and constructors, New York City.

Spier Falls plant, built in 1903, was a pioneer in high-head hydro-electric development. The dam has a maximum height of 80 ft. with a total length of 1,500 ft., and at the time of its construction it was the fourth largest dam in the world. For many years the largest power source in eastern New York, its present enlargement will give it even greater significance in the power development of the entire state.

The Newport News Shipbuilding & Dry Dock Company, the builder of the turbine, supplies the following data concerning it: Horsepower, 57,000; r.p.m., 81.8; head, 81 ft.; estimated weight, complete, 800 tons; estimated weight of runner, 150 tons.

Briefer News

New Peak Load for New Jersey Public Service Electric & Gas.—The power stations of the Public Service Electric & Gas Company were called upon to furnish a record output of electricity on the afternoon of December 16, when at 4:50 p.m. the "load" built up a new high record of 536,600 kw. The previous peak-load record was 486,500 kw. on December 17 of last year.

Unprecedented Fog in New York City Boosts Central-Station Output.—The New York Edison Company and the associated electric light and power companies serving the boroughs of Manhattan, the Bronx, Brooklyn and Queens and the city of Yonkers report that for the 24-hour period ending midnight Tuesday, December 17, the almost unprecedented fog prevailing in the city rolled up the heaviest load the system has ever carried. Tuesday's output amounted to 17,289,820 kw.-hr., which is about 11 per cent higher than the biggest day in 1928. On Wednesday the total dropped to 17,031,585 kw.-hr. The peak load on Tuesday was not, however, so high as the peak on some other days, and the increase in output was due to a heavy continued demand throughout the day.

Los Angeles Water and Power Department Again Reorganized.—The Los Angeles Board of Water and Power Commissioners has reorganized the Los Angeles Department of Water and Power and has set up two separate bureaus, one to be known as the Bureau of Power and Light and the other as the Bureau of Waterworks and Supply. This, in effect, has re-established the municipal bureaus as they were nine months ago. At that time H. A. Van Norman was made general manager of the combined departments. Under the new plan he will be general manager and chief engineer of the waterworks of the Bureau of Waterworks and Supply. E. F. Scattergood is to be general manager and chief engineer of the Bureau of Power and Light.

Two Defeats for Municipal-Plant Projects in Kansas.—At Junction City, Kan., a proposed bond issue of $425,000 for the construction of a municipal electric plant and distribution system to compete with the plant of the United Power & Light Corporation was defeated at a special election by 595 votes, or approximately two to one. A bond election in the newly incorporated city of Hanston, Kan., on a proposal to issue bonds with which to construct an electric light and power system was likewise defeated.

Memphis Power & Light Completes Nineteen-Mile Ring Transmission Line.—Chief among construction undertakings by the Memphis Power & Light Company in 1929 has been the completion of 19 miles of high-tension transmission line around the city. This line is between a mile and three miles from the new city limits and connects with seven miles of high power line already built to the north of the city, completing a line about the city carried on 82-ft. steel towers. Ground has been purchased for substations to be erected at Oakville, Brookfield and Cedar Grove.

Arizona Light & Power Gets New Franchise in Phoenix.—By a ratio of three to one voters of Phoenix, Ariz., on December 17 approved the granting of a new 25-year franchise to the Central Arizona Light & Power Company. The new compact will replace the present 50-year franchise, which still has six years to run. The company asked for the grant on the ground that the six years left under its present franchise were not sufficient for financing its program, which includes the construction of a steam plant. Provisions of the new franchise are the same as those of the old except that there is a provision that the company shall pay a tax of 2 cents per $100 gross earnings to the city, the tax not to fall below $500 per year, in lieu of all other franchise or occupational taxes.

Bremerton (Wash.) League Attacks Rates, and City Commission Considers Municipal Plant.—In a complaint filed by the Bremerton (Wash.) Municipal League a complete investigation of rates of the Puget Sound Power & Light Company in its three divisions in Kitsap County has been requested of the State Department of Public Works. The company's rates are termed "excessive, unfair, discriminatory and unjust" in the complaint, which declares that rates should be reduced 50 per cent to give the company no more than a reasonable return on its

investment. At the same time the City Commission has voted unanimously to start proceedings to acquire by purchase, condemnation or construction a plant for the supply of electrical energy to Bremerton. Action along these lines will depend largely on whether a market can be found for the sale of the bond issue of $750,000 authorized by the people last May.

FOUR LOUISIANA TOWNS RENEW ELECTRIC FRANCHISES.—On December 3 the Board of Aldermen of Breaux Bridge, La., granted the Gulf Public Service Company a new standard 25-year electric franchise, replacing the one granted the company in 1914. This is the fourth renewal of existing franchises obtained by this company in the past six months, the other three being Winnfield, Jena and Cotton Valley, La. The Gulf Public Service Company operates utilities in 29 towns in Louisiana. It is a subsidiary of the American Community Power Company of St. Louis, Mo.

N.E.M.A. WILL HAVE ITS MIDWINTER MEETING NEXT MONTH.—The National Electrical Manufacturers' Association announces that it will hold its midwinter meeting in New York the week of January 20, at its headquarters, 429 Lexington Avenue; the Lighting Institute in the Grand Central Palace and the Hotel Commodore. A large attendance is expected, including representatives from all of the supply sections and most of the apparatus sections. A general session is scheduled for Tuesday, January 21, at the Lighting Institute. A meeting of the section council, composed of all section chairmen, will be held early in the week. The dinner meeting will be at the Hotel Commodore.

"TALKING MOVIE" ON WILLIAM STANLEY AND THE TRANSFORMER.—At a recent meeting of the William Stanley Club of Pittsfield, Mass., an interesting feature was the showing of a "talking movie" on William Stanley and the transformer. The picture introduces G. Faccioli, S. W. Ashe and E. A. Wagner, all of the Pittsfield works of the General Electric Company, and tells through them a brief story of the development of the transformer and the results of Stanley's work. It shows what can be done by means of experiments to illustrate the fundamental electrical laws and to show their practical applications. The film can be used on any standard "talking movie" outfit.

FINAL APPROVAL OF NEW YORK CITY SUBWAY POWER CONTRACT.—The modified form of contract under which the city of New York will buy electrical energy from the New York Edison Company for the new Eighth Avenue-Washington Heights subway for ten years following its opening was approved last week by the Board of Estimate of the city, this being virtually the last step necessary for the operation of the subway. The supplementary agreement permits cancellation of the contract on 60 days' notice should the service prove unsatisfactory or should the city decide to build its own power plant. When the Eighth Avenue subway is in operation, scheduled for 1931, it will be the largest single consumer of New York Edison Company energy, according to figures submitted to the Board of Estimate. The ten-year cost of energy is put at $36,381,000.

NORTH WASHINGTON TOWN TO CEASE IMPORTING CANADIAN POWER. — The Puget Sound Power & Light Company has signed an agreement with the Sumas (Wash.) City Council to furnish power for the municipal power and light system. The new contract is for ten years at a reduction of about 25 per cent from the price paid the British Columbia Electric Railway Company, which has been supplying power to the city for twenty years.

SMALL NEW HAMPSHIRE COMPANY SEEKS FIFTEEN-MILE FALLS POWER.—The Groveton (N. H.) Electric Company has petitioned the New Hampshire Public Service Commission for authority to extend its lines to Littleton and there connect them with the lines of the Grafton Power Company. The commission is asked also to order the Grafton Power Company to deliver energy to the Groveton company. The petition is the first of its kind under an act of 1929 which permits the commission to order a large company to deliver power to a small one, with the idea of protecting small electric power companies.

Coming Meetings

[A complete directory of electrical associations, with their secretaries, is published in the first issue of every volume. For latest list see issue of July 6, page 46.]

American Engineering Council—Washington, Jan. 9-11. L. W. Wallace, 26 Jackson Place, Washington, D. C.

Conference of Electrical Leagues—Westinghouse Lighting Institute, New York, Jan. 13-16. Society for Electrical Development, 420 Lexington Ave., New York.

Empire State Gas and Electric Association—Women's Section, Hotel Seneca, Rochester, Jan. 16-17. C. H. B. Chapin, Grand Central Terminal, New York.

National Electrical Manufacturers' Association—New York, Jan. 20-24. S. N. Clarkson, 420 Lexington Ave., New York.

North Central Division, N.E.L.A.—Commercial Section, St. Paul Hotel, St. Paul, Jan. 20-21; Engineering Section, Nicollet Hotel, Minneapolis, Feb. 24-25. J. W. Lapham, 803 Plymouth Bldg., Minneapolis.

National Electrical Credit Association—New England Division, University Club, Boston, Jan. 21. F. P. Vose, 1008 Marquette Bldg., Chicago.

National Association of Purchasing Agents—Public utility group, Mayflower Hotel, Washington, D. C., Jan. 23-24. G. A. Renard, 11 Park Place, New York.

American Institute of Electrical Engineers—Winter meeting, New York, Jan. 27-31. F. L. Hutchinson, 33 West 39th St., New York.

National Electrical Wholesalers' Association—Pacific Division, Del Monte, Calif., Jan. 31-Feb. 1.

Artistic Lighting Equipment Association—Washington, Feb. 9-15. C. L. Benjamin, 420 Lexington Avenue, New York.

NIAGARA-HUDSON POWER CORPORATION TO MAINTAIN OFFICES IN FOUR CITIES.—Four Niagara-Hudson Power Corporation offices will be maintained, that organization has just announced—at Albany, at Buffalo, at Syracuse and in New York City. It was pointed out that Albany is the logical center for the company's eastern territory, Syracuse for the communities served in the central part of the state and Buffalo for the western section.

REFERENDUM ON LEAGUE OF MUNICIPALITIES' MEASURES SOUGHT IN NEBRASKA.—The Nebraska League of Municipalities is planning to bring about the submission to the voters next November by initiative of its proposed laws to give cities and villages added powers in the matter of municipal ownership and management of electric lighting plants and waterworks. Most of the measures suggested were submitted to the Legislature in the spring, but with one exception were defeated. If approved on referendum, they will become law without legislative intervention.

PECOS VALLEY PLANT TO BE ENLARGED AND EXPANDED. — The Pecos Valley Power & Light Company, which was recently purchased by the Insull interests of Chicago, owns an electric power station on the Pecos River near McCamey, Tex. The plant was constructed in 1925 and is equipped with three units with a total rating of approximately 20,000 hp. The company has a system of transmission lines from the power station to the oil fields of Pecos, Reagan, Upton and Crane Counties. As a result of the purchase this transmission system will be extended and interconnected with the lines of the other Insull subsidiaries in Texas.

HARDY STREET GENERATING PLANT, INDIANAPOLIS, TO BE PUSHED.—A very large expenditure on its new Hardy Street steam-electric generating plant is announced for 1930 by the Indianapolis Power & Light Company. This plant, of which the the first unit, scheduled for completion in 1931, will be rated at 70,000 kw. and cost $10,000,000, will ultimately have double that capacity.

EXPLOSION HITS SERVICE AT COLUMBUS, OHIO.—Fifty-four 250-volt direct-current feed lines at Columbus, Ohio, were put out of commission by an explosion following a fire in underground cable lines of the Columbus Railway, Power & Light Company at Gay and Lazelle Streets on the afternoon of December 18, and service was cut off in a portion of the business area, causing theaters and restaurants to resort to candle lighting, shops to close and newspapers to delay or suspend publication. Repairs were begun immediately and pushed strenuously, and by noon of the next day thirty of the circuits were fully repaired and work on the others was drawing to an end, thus accomplishing what company men termed a two weeks' job in about 24 hours.

PROPOSED TRANSMISSION LINES IN SOUTH ALABAMA. — The Alabama Power Compay has applied to the Alabama Public Service Commission for permission to build a 44,000-volt line from Flomaton, Ala., to a point near Uriah, in order to serve the properties it is acquiring from the Gulf Utilities Company. The River Falls Power Company has a petition for permission to build a line from Evergreen to Frisco City, Ala., which would approach the same territory.

MUSCLE SHOALS-NASHVILLE 154-KV. TRANSMISSION LINE TO BE PUSHED.—Among the major items in the Tennessee Electric Power Company's 1930 construction budget of $7,500,000 is the completion of a 154-kv. transmission line from Muscle Shoals, Ala., through Iron City and Centerville, Tenn., to South Nashville. Power will be distributed in Nashville and other points from a new substation in West Nashville.

A.S.A. JOINS INTERNATIONAL STANDARDS ASSOCIATION.—Announcement that the American Standards Association has become a member body of the International Standards Association was made at the annual meeting of the A.S.A. in New York on December 18 by President William J. Serrill. As the result of this action all of the national standardizing bodies except those of Great Britain, Canada and Australia are members of the international association. Mr. Serrill has been re-elected president and Mr. Cloyd M. Chapman vice-president for the year 1930.

Commission Rulings

IN ABSENCE OF DETAILED COST OF MANAGEMENT BY OUTSIDE COMPANY WISCONSIN COMMISSION DISALLOWS ENTIRE ITEM.—In rate proceedings before the Wisconsin Railroad Commission, the Wisconsin Public Utility Company set up as the cost of management by the Central Public Service Corporation of Chicago approximately 3 per cent of its gross income, or the sum of $6,600. Declaring that it was entitled to have in evidence the actual cost of such services, the commission, since these data were not available, disallowed the whole item. It also reduced a claim of going value amounting to 20 per cent of the reproduction cost new of the company's property, based upon the company's valuation, to 10 per cent of the physical value as fixed by the commission.

JOBBING AND MERCHANDISING RECEIPTS PART OF OPERATING REVENUE.—In passing upon rates for the Vallejo Electric Light & Power Company the California Railroad Commission said: "It is suggested by the company that miscellaneous jobbing and merchandising revenue should not be considered as operating income. It has always been the practice of the commission in rate proceedings to consider this as part of the operating revenue. The same quarters and the same employees are used to carry on this branch of the business; it is a mere incident of the business and is used to attract business, and the expenses of conducting it are largely absorbed in various operating expense accounts. It is neither practicable nor reasonable to set this activity of the utility off by itself."

FLAT RATES FOR WATER HEATERS FORBIDDEN.—Maintaining that except in cases where both the size of the installation and the actual hours' use per month are definitely determined, the flat electrical rate is unscientific and undesirable and tends to encourage waste, the Wisconsin Railroad Commission readily complied with a request of the Kaukauna electrical department to eliminate flat rates for water heaters which amounted to less than the actual average cost to the utility of the generated and purchased energy used and were therefore held to constitute an unjust burden on other consumers.

NEBRASKA COMMISSION ON "COMMON CARRIERS" AND PUBLIC SERVICE CORPORATIONS.—The State Railway Commission of Nebraska holds that where the evidence taken in an application for approval of a securities issue discloses that a corporation organized in the state for a specific purpose is not attempting to exercise the power of eminent domain, that it does not hold itself to sell at retail the product that it transports and does not offer its facilities for the use of others for hire, it is not a common carrier under the meaning and definitions of the Nebraska statute. Where it is also disclosed that the company proposes to transport only the product purchased and owned by it and sell only to distributing companies, it will be held not to be a public service corporation. These being the only two classes of corporations over which the commission is given supervisory powers, it has dismissed the application of the Nebraska Pipe Line Company for approval of $2,500,000 of securities that it has contracted to sell the North American Light & Power Company, with which it is affiliated. The company buys natural gas at the Kansas-Nebraska border and sells it at wholesale in various towns to distributing companies. The commission says that where the legislation on the subject of pipe lines in connection with rates and service confines its jurisdiction to such lines as are common carriers, it will not seek to extend its power farther. The applicant company, after filing the request for approval as a matter of legal caution, challenged the commission's jurisdiction.

Recent Court Decisions

NORMAL ERECTION OF TRANSFORMER THAT FELL AND KILLED DRIVER COLLIDING WITH POLE NOT A SUFFICIENT PLEA.—In Lim Ben vs. Pacific Gas & Electric Company damages awarded because of the death of a laundryman whose delivery car swerved from the road and struck one of the company's poles, causing a transformer to fall from it and strike the victim on the head, were confirmed. The defence was based on the plea that the method of suspension of the transformer was normal and that the deceased was guilty of contributory negligence. The First District Court of Appeal held that the question of whether the company was negligent in hanging a 750-lb. metal transformer from the cross-arm of a 40-ft. pole but one foot from the curb of a public street traveled by automobiles, by means of half-inch hangers extending but 1¼ in. down over cross-arm, was for the jury to decide, and that the question of contributory negligence as the proximate cause of the injury was also a jury issue. (281 Pac. 634.)*

TRESPASS ON ANOTHER'S PROPERTY IN ORDER TO REBUILD HYDRO WORKS WASHED AWAY FORBIDDEN.—The California-Oregon Power Company sued the city of Gold Hill and the Beaver Portland Cement Company because the latter, having leased a small hydro-electric plant belonging to the former, and having failed in an effort to condemn property of the power company in order to extend the dam and enlarge the plant, began the construction of a wing dam mainly upon the site of a previous wing dam belonging to the city that had been washed away. This the power company brought suit to enjoin, claiming that any easement owned by the city had been lost by abandonment and that the dam could not be built without trespassing on its property. A decree forbidding the dam was sustained with modifications by the United States Court of Appeal, without prejudice to the rights which either contestant might have under the principles of riparian law or by appropriation. The court found that there was no evidence to show abandonment of a crib pier that had stood until 1927 or of its site, but that to rebuild the pier or the dam the defendants could not trespass on the power company's property. (35 Fed. [2d] 317.)

REVENUE FROM MUNICIPAL PLANT SHOULD NOT GO TOWARD GENERAL EXPENSES.—The Michigan Supreme Court has held, in Freeland vs. City of Sturgis, that the city should not use the revenue received from its municipally owned hydro-electric plant to pay the general expenses of the city since the city charter did not authorize such appropriation and a state statute expressly forbade it. In remanding the cause to the lower court, which dismissed the bill as not stating a cause of action, the Supreme Court said: "The plaintiffs are three resident taxpayers of the city of Sturgis. They claim to have filed their bill in their individual capacities for the redress of private injuries. It is alleged that they are users of a large amount of electrical energy; that the effect of the illegal action of the city is to compel them to pay a greater portion of the general expenses than they should pay and practically to exempt from taxation for such expense large property holders who do not use any considerable quantity of light and power; that the plaintiffs may suffer further damage by the transfer of the utility fund to the general expense account of the city instead of using it for the proper rehabilitation of the plant and for retiring the bonded indebtedness; that, in the absence of a surplus or sinking fund out of which to meet these expenditures, there is an ever-present danger of assessments against the plaintiffs' property; that they are owners of industries which use large amounts of electrical energy, and that the misappropriation of the utility receipts by the city without retaining a fund for maintenance and for payment of the bonded indebtedness hazards their property and its earning capacity. These allegations show that a substantial injury threatens the plaintiffs and are sufficient to confer jurisdiction at the suit of individual taxpayers." (226 N.W. 897.)

*The left-hand numbers refer to the volume and the right-hand numbers to the page of the National Reporter System.

News About Men of the Industry

C. F. Scott Recipient of Edison Medal

Charles F. Scott, educator and engineer, who was awarded the Edison Medal of the American Institute of Electrical Engineers, as announced in the December 21 issue of the ELECTRICAL WORLD, has been an outstanding figure in electrical activities for a number of years. Before assuming academic duties at Yale University, he obtained considerable practical engineering experience with the Westinghouse Electric & Manufacturing Company. Entering the testing department in 1888, he worked in the dynamo room, the laboratory and, on the development of alternating-current motors, became assistant electrician and in 1897 chief electrician. In 1904 he was made consulting engineer of the company. During his connection with the Westinghouse company he was a pioneer in high-voltage transmission of power and in the development of several types of equipment, including induction motors and transformers. It was in 1911 that he was appointed to his present position at Yale University.

A past-president of the American Institute of Electrical Engineers, Professor Scott has served on many Institute committees, and is at present a member of the Lamme medal and student branches committees and representative on the Commission of Washington Award and the American Engineering Council. As president of the Society for the Promotion of Engineering Education (1921-1923) he proposed a serious consideration of methods of improving the teaching of engineering. He has served as chairman of the board of investigation and co-ordination in this undertaking, in which there has been active co-operation of engineering schools, engineering societies and industry. In addition he is a member of the American Society of Mechanical Engineers, Illuminating Engineering Society, American Philosophical Society and Engineers' Society of Western Pennsylvania (past-president). Professor Scott has contributed a large number of papers to the publications of the engineering societies and other technical periodicals, in addition to being an active committeeman.

COLONEL THAD H. BROWN, chief counsel of the Federal Power Commission, resigned that position to become general counsel of the Federal Radio Commission to succeed Bethuel M. Webster, Jr., resigned. Colonel Brown, who served as chairman of the Ohio State Civil Service Commission from 1920 to 1922, was also Secretary of State of Ohio for two terms. He has held the Federal Power position since last July. No decision has been made as to Colonel Brown's successor on the Federal Power Commission.

New York Power & Light Elects New Officers

Charles S. Ruffner, president of the New York Power & Light Corporation since its organization in 1927, has been elected chairman of the board, succeeding Charles S. Brewer, who has resigned. Mr. Brewer is chairman of the board of the Mohawk Hudson Power Corporation and will continue in that office. Mr. Ruffner is president of the Mohawk Hudson Power Corporation. As Mr. Ruffner's successor in the presidency of the New York Power & Light Corporation the directors elected Otto Snyder, who has been executive vice-president of the company since it was formed.

Vivian Now Vice-President of Middle West Utilities

W. S. Vivian, who was made a vice-president of the Middle West Utilities Company in charge of public relations, as announced in the December 21 issue of the ELECTRICAL WORLD, is widely known throughout the electric utility industry, especially for his work as chairman of the public speakers committee, Public Relations Section, National Electric Light Association.

Mr. Vivian has been director of public relations of the company since 1923 and occupied the same position with the Automatic Electric Company for the three years previous. Before transferring his interests to the Middle West Mr. Vivian had been conspicuously identified with the telephone business, having served as secretary-treasurer and vice-president of the United States Independent Telephone Association. From 1900 to 1913 he was actively engaged in telephone plant operation. Mr. Vivian was born at Delhi, Ont., but spent his boyhood and youth in the timber country of Michigan. His formal education consisted of a very brief exposure to culture at the Ferris Institute in Michigan, but the lack of degrees and certificates has, as is apparent, hampered neither his development nor progress.

H. E. Duren Vice-President of Massachusetts Company

Harry E. Duren, who was recently elected vice-president of the Greenfield (Mass.) Electric Light & Power Company, retaining the general managership of that utility, is well known in New England operating circles. He was educated at the University of Maine and his early career included service in the testing department of the General Electric Company at Schenectady and in the power and mining department of that organization. From 1906 to 1915 he was stationed on the Pacific Coast, and in the latter year entered the central-station field, joining the staff of the Newburyport (Mass.) Gas & Electric Light Company. Two years later he went to Greenfield, Mass., and was employed by the Turners Falls Power & Electric Company, later being transferred to the Fall River Electric Light Company. Since 1921 he has been manager of the Greenfield company and has done notable work in the sphere of rates and public relations.

HERMAN RUSSELL, new president of the Rochester Gas & Electric Corporation, was the guest of honor at a dinner given at the Oak Hill Country Club on Monday, December 16, by department heads and division superintendents. Charles L. Cadle, vice-president and general manager, was toastmaster. About 100 executives were present.

J. LEE POTTER has been elected a vice-president of the banking house of Arthur W. Wood Company, Boston, Mass., following four years of security sales work in that organization. He was formerly general manager of the Newburyport (Mass.) Gas & Electric Light Company and is well known in New England utility circles.

ERWIN E. DREESE, chief engineer of the Lincoln Electric Company, Cleveland, has been appointed professor of electrical engineering in the College of Engineering, Ohio State University. Although he is only in his middle thirties, Mr. Dreese has won a place as an outstanding electrical engineer. Following graduation from the University of Michigan, he taught at that institution for four years, and has been with the Lincoln Electric Company for the last five years. His acceptance of the appointment was made possible through the co-operation of James F. Lincoln, president of the Lincoln Electric Com-

pany, a graduate of Ohio State and formerly president of its national alumni association. In recognition of his generosity in permitting Mr. Dreese to leave his employ, the university board of trustees expressed its formal thanks to Mr. Lincoln.

S. Piek Executive Vice-President in Utica

Stefaan Piek of Buffalo, who was elected executive vice-president of the Utica Gas & Electric Company, as announced in the December 21 issue of the ELECTRICAL WORLD, has had a long and broad career in public utility work. He is vice-president and general manager of the Niagara, Lockport, & Ontario Power Company, one of the subsidiaries of the Niagara Hudson Power Corporation. Born in Holland and educated in Holland and Switzerland, Mr. Piek's first association in this country was with the Westinghouse Electric & Manufacturing Company at Pittsburgh. Later he went to Buffalo as assistant electrical engineer of the Lackawanna Steel Company and later entered the employ of the Ontario Power Company of Niagara Falls, Ont., as electrical engineer. In 1905 he became assistant superintendent of the Iroquois Construction Company, which is associated with the Niagara, Lockport, & Ontario Power Company. Later he became superintendent of the Niagara, Lockport, & Ontario Power Company, succeeding in 1909 to the position of assistant general manager, in 1913 general manager, and in 1923 he was made vice-president of the company. Mr. Piek is a member of the American Institute of Electrical Engineers, American Society of Mechanical Engineers and American Electric Railway Association.

R. K. JEFFRIES, formerly manager of the Dixie Construction Company's warehouse and shops, has been appointed manager of the Montgomery district of the Alabama Power Company to succeed T. T. McLemore, resigned.

S. S. EVANS, for the past two years head of the engineering department of the Empire District Electric Company, Joplin, Mo., and for nearly ten years a member of the Empire organization, has been made manager of the Defiance division of the Toledo Edison Company. Mr. Evans joined the Empire District organization in the distribution department. His first advancement was to the position of foreman of the meter department and the following year he was made assistant superintendent of distribution, being promoted to head of the engineering department a little more than two years ago.

Niagara Hudson Power Elects New Officers

The Niagara Hudson Power Corporation has announced additions to its staff of officers. These additions included Charles S. Ruffner, Albany, vice-president; William Kelly, Buffalo, vice-president; Stefaan Piek, Syracuse, vice-president; Charles E. Norris, New York, secretary; W. Paxton Little, New York, treasurer. Alfred H. Schoellkopf, formerly vice-president, was elected executive vice-president. Other officers of Niagara Hudson are: Floyd L. Carlisle, chairman of the board; George H. Howard, chairman of the executive committee, and Paul A. Schoellkopf, president.

A. H. Stack New General Manager in Utica

A. H. Stack, who was named general manager of the Utica Gas & Electric Company, as announced in the December 21 issue of the ELECTRICAL WORLD, brings to the company a varied experience in utility work. In 1914 he became associated with the Denver Gas & Electric Company and later with the Cities Service Company on appraisals, valuations and rates at Bartlesville, Okla.; Hutchinson, Kan., and Mount Vernon, Ill. Mr. Stack was then appointed district superintendent of the Ohio Service Company at New Philadelphia and at Coshocton, Ohio. From 1919 to 1924 he was manager of the Warren Light & Power Company, Warren, Pa., later developing several small utilities in Ohio. One year later he became division manager of the Adirondack Power & Light Corporation for its northern division, embracing Glens Falls, Hudson Falls, Fort Edward, Whitehall, Lake George, Warrensburg and Chestertown. On the formation of the New York Power & Light Corporation at Albany. Mr. Stack became assistant to the executive vice-president, resigning to associate with the Utica Gas & Electric Company.

JAMES L. CROSS has been named manager of the Belleville district of the Illinois Power & Light Corporation to succeed John R. Hoffman, who has been made manager of the Jacksonville, Ill., territory. Mr. Cross was formerly at Sparta, Ill.

JAMES A. PERRY, a member of the Georgia Public Service Commission since 1911 and chairman of that body since 1926, has announced his candidacy for the Governorship of Georgia. Following graduation from the University of Georgia law school in 1898, he began the practice of law in Lawrenceville, Ga. Upon the death of his father, in 1894, Mr. Perry conducted his plantation, as well as continuing the law practice which he had built up, and in 1900 he was elected Mayor of Lawrenceville. Later he was elected a representative in the Georgia Legislature for his district. It was in 1911 that he was elected a member of the Public Service Commission of Georgia.

S. S. EVANS, formerly connected with the Empire District Electric Company, Joplin, Mo., has been transferred to the Defiance division of the Toledo Edison Company as manager.

H. C. LEONARD, formerly manager of the light and power department of the Virginia Electric & Power Company in Norfolk, has been transferred to Richmond as general manager of the electric department in that city. Mr. Leonard, who has been with the Stone & Webster interests for eight years, succeeds Robert J. Throckmorton, who has been named vice-president of the company, Norfolk division.

Obituary

HERR A. V. ZELEWSKI, chief engineer of the transformer works of the Allgemeine Elektrizitäts Gesellschaft, died recently in Berlin, Germany, at the age of 53. Mr. Zelewski, who was born in Rome, Italy, was an authority on transformer design and construction.

H. H. NOBLE, a pioneer in the hydroelectric field and in electric smelting, died in San Francisco December 19 in his eighty-fifth year. In 1900 he organized the Keswick Electrical Power Company, in this venture having been associated with Eugene de Sable and John Martin. These men developed the Northern California Power Company, which was eventually consolidated with the Pacific Gas & Electric Company.

E. H. PEARSON, New York district manager of the Electric Machinery Manufacturing Company, died suddenly December 7. Mr. Pearson was born in Malmö, Sweden, on September 10, 1893. His early life was spent in Sweden, and he received some of his technical education at the Institute of Technology in Malmö. In 1916 Mr. Pearson entered the employ of the Electric Machinery Company as a service engineer for the Minneapolis district, which position he held until the fall of 1920. At that time he was transferred to the New York office, where he continued his work as a service engineer. In the fall of 1921 he entered the sales organization of the Electric Machinery Manufacturing Company at New York, where he remained until the fall of 1928, when he was made manager of the New York district office. He was a member of the American Institute of Electrical Engineers, the American Society of Refrigeration Engineers and other technical associations.

Financial and Statistical News

ONE OF THE salutary effects of the market break and subsequent period was the opportunity afforded the bond market to get cleared of undigested securities. Few large issues still remain to be absorbed. Dealers have kept their inventories low and the bond market outlook for early 1930 is decidedly good.

——YEAR-END CHECKS OF SHAREHOLDER LISTS show an exceedingly wide distribution of power and light stocks during and after the market recession. The sudden increase in number of shareholders of leading power and light companies shows that thousands of new investors took advantage of the market break to acquire utility stocks as an investment.

Niagara Hudson Controlled by Four Groups

Niagara Hudson Power Corporation is controlled by four leading groups, no three of which together have voting control over the company, a statement made by Floyd L. Carlisle, chairman of the board, before a special legislative commission last week showing holdings of the principal stockholders as of December 3, indicates.

It was shown that the Carlisle, or St. Regis Paper, holdings amount to 18.1 per cent of the total stock outstanding, after deducting intercompany holdings; the Schoellkopf holdings total 15.0 per cent, the Morgan group owns 14.4 per cent and the Mellon, or Aluminum Company of America, holdings are 10.7 per cent. The three largest holdings total only 47.5 per cent, or less than a majority, while the four groups together own 58.2 per cent of the stock.

Leading holders of Niagara Hudson Power stock as of Decembeer 3 were as follows:

Holder	Shares
St. Regis Paper Co.	4,240,370
Niagara Shares and Schoellkopfs.	2,500,000
Aluminum Co. of America	2,500,000
United Gas Improvement	1,800,000
United Corp.	1,200,000
American Superpower Corp.	301,000
J. P. Morgan & Co.	72,000
Brady family	50,000
Frank M. Tate, Dayton, Ohio	75,000
M. S. Wilder, Watertown, N. Y.	145,873
M. J. Warner, Pine Orchard, Conn.	148,662

There are 77,000 stockholders, each of whose holdings amounts to less than 50,000 shares, the statement indicated. The total stock outstanding is 25,102,351 shares.

Cities Service Earnings

Cities Service Company's net earnings for November were $4,314,815, an increase of 36 per cent over the same month last year and a high record for any month in the history of the company. Net earnings for the year ended November 30 were also the largest for any twelve months, amounting to $41,650,882.

Net earnings for the twelve months were 6.09 times interest and discount on its debentures. Net earnings to stocks and reserves amounted to $34,818,897, or 5.09 times preferred stock dividends. This compares with $29,447,023, or 4.34 times, for the corresponding period a year ago. Net to common stock and reserves rose to $27,982,813, or $1.14 per share on the average number of shares outstanding and an increase of $5,312,829 over the corresponding period a year ago.

Boston Edison Withdraws Petition to Issue Stock

Edison Electric Illuminating Company of Boston has for the present abandoned its attempt to split its common stock, it is understood. Directors voted to withdraw the petition for authority to issue 76,411 additional shares and have thereby, apparently, decided not to contest the opposition of the Department of Public Utilities to the split-up, at least for the present.

Original proposals for a reduction in par value of the stock from $100 to $25 a share and issuance of four new shares for each share of the $100 stock was flatly rejected by the department on the ground that the step was not in the public's interest.

New York Edison Budget Shows Slight Decline

THE New York Edison Company and associated electric light and power companies serving Manhattan, Bronx, Brooklyn, Queens and Yonkers will in 1930 spend $76,848,053 for construction purposes, according to the budget just approved, Matthew S. Sloan, president of these companies, announced, against $80,000,000 in 1929.

The principal items of the budget are as follows: Generating stations, $20,581,095; substations, $1,204,008; buildings and yards, $2,458,000; transmission and distribution. $50,250,000; miscellaneous, $2,354,000, of which transportation equipment will take $1,000,000. The $20,581,095 for generating stations is allocated to three of the companies of the local system as follows: New York Edison Company, $4,572,270; Brooklyn Edison Company, $7,341,000; United Electric Light & Power Company, $8,667,825.

The largest allocation for substations is $630,800 to the New York Edison Company. Allotments to the other companies are: $233,708 to the United Electric Light & Power Company, $151,500 to the New York & Queens Electric Light & Power Company, $101,000 to the Brooklyn Edison Company and $87,000 to the Yonkers Electric Light & Power Company.

The big item of the budget, both as to amount, $50,250,950, and value to the community through increased efficiency and economy of operation by the companies and added security of service to consumers and enhancement of property values in improved appearance of streets, is that for transmission and distribution purposes. This item carries along a ten-year program, in which last year $40,500,000, or more than half of the 1929 budget, was expended. This program provides for extension and improvement of the transmission and distribution lines of the system, with extensive removal of overhead lines and their replacement by underground transmission. Manhattan has had underground transmission since the beginning of the electric light and power industry in 1882, when Pearl Street station was built by Thomas A. Edison, and the more congested portions of the other boroughs have had underground transmission for years. Other sections still have overhead transmission.

The allocation of the $50,250,000 item for transmission and distribution by boroughs is as follows:

Manhattan and Bronx, New York Edison, $5,735,500; United Electric Light & Power Company, $5,160,150; Brooklyn, Brooklyn Edison Company, $20,600,000; Queens, New York & Queens Electric Light & Power Company, $17,310,300; Yonkers, Yonkers Electric Light & Power Company, $1,445,000.

Mr. Sloan explained that in the program to place lines underground the element of greatest value to the consumers is the changing over from a system of distribution known as a radial distribution to a newly developed system called network distribution.

The Portland Electric Power Company, in 1930, will spend $4,300,000 on

new construction in the light and power department, according to Franklin T. Griffith, president. This is more than double the 1929 construction expenditures and amounts to about $40 per customer.

The largest item is for increase and betterment of generating facilities, $2,601,750, which covers the installation of a new 35,000-kw. steam turbine at station L, and an additional waterwheel and generator of 25,500 kw. capacity at the Oak Grove hydro-electric plant. The foundations for the new hydro unit were completed in 1929, and during 1930 the power house will be enlarged and the additional turbine and generator will be installed. This is the second step in the development of this site, which originally contemplated three successive steps.

Important transmission improvements scheduled for 1930 are a new steel-tower, 60-kv. line from the River Mill hydro plant at Estacada about 12 miles to Beaver Creek, a central point on the transmission system, and an increase from 33 kv. to 60 kv. of the line from Portland to St. Helens. The increase on the Portland-St. Helens line is made necessary principally by the 4,000-hp. demand of the new Fir-Tex Insulating Board Company's plant, now under construction at St. Helens. The total budget item for transmission is $238,350.

It is shown by figures compiled by the Texas Public Service Information Bureau of Dallas that the capital expenditures of the utility companies of Texas for improvements, extensions and general betterments during the 1930 will exceed $70,000,000. Detailed reports were received from twenty of the larger public utility companies which showed budgeted improvement items for next year aggregating $59,249,000. Estimate of $11,000,000 for the several major companies not reporting may be ultra-conservative, as the omissions include some of the largest operators in Texas.

In addition to the larger companies for which estimates were made and included in the grand total above, the 300 or 400 independent telephone companies will spend $1,500,000 in permanent improvements next year, it is estimated by R. B. Still, president of the Independent Telephone Association, and many smaller utility companies are known to have considerable improvement work planned for the year.

October Central Station Operations Show Seasonable Rise

Revenue, $177,800,000, Is $7,700,000 More than in September—Exceeds Last Year by 7.8 per Cent—New Energy Records, Add Three-quarter Billion Kw.-Hr. to September Output

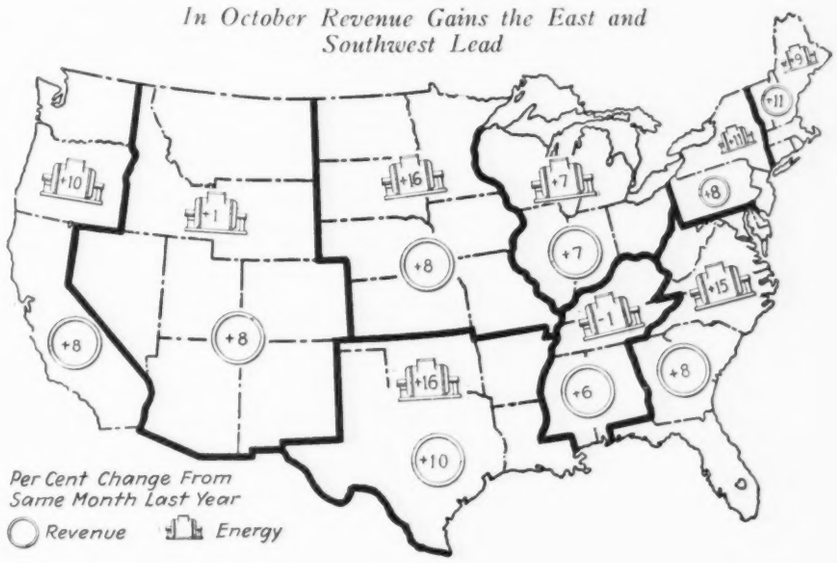
ALL PREVIOUS records for energy output of electric light and power plants were far exceeded, in October, when the amount generated rose to 8,295,839,000 kw.-hr., compared with 7,680,180,000 in September and 7,963,547,000 kw.-hr. in August, the high month until this time. The gain over the production in October of last year was virtually 10 per cent.

Electrical energy output is, broadly, a measure of industrial activity, if account is properly taken of the normal increase due to the steady advance in the application of electric power and to the effect of the changing seasons. The latter factor, it may be noted, is gradually diminishing in importance as the lighting load loses in relative magnitude because of the ever-expanding power load.

The percentages of increase over the corresponding months of 1928 indicate that there has been a progressive but moderate slackening in the pace. Up to the end of October, as Table III indicates, the rate of gain fell gradually from the maximum of 13 per cent in July, by about 1 per cent a month.

The variations in revenue have been smaller, the gains over last year being, during the four months recorded in Table I, 8.8, 10.2, 9.0 and 7.8 per cent respectively. The fact that these figures are smaller than those for energy generated is evidence of a reduction in the average selling price.

In October Revenue Gains the East and Southwest Lead



The extremely low stream flow that has prevailed for a number of months continued through October, though less severe than in the early autumn. The output from hydro plants was 5.6 per cent less than a year ago, that from steam 19 per cent greater than in October, 1928. The effect was to increase the coal consumption by 6.6 per cent to 3,758,000 tons, the oil by 72.6 per cent to 1,028,148 barrels, the natural gas by

Table I—Central-Station Financial Operations in the United States

Compared with Corresponding Month of Previous Year

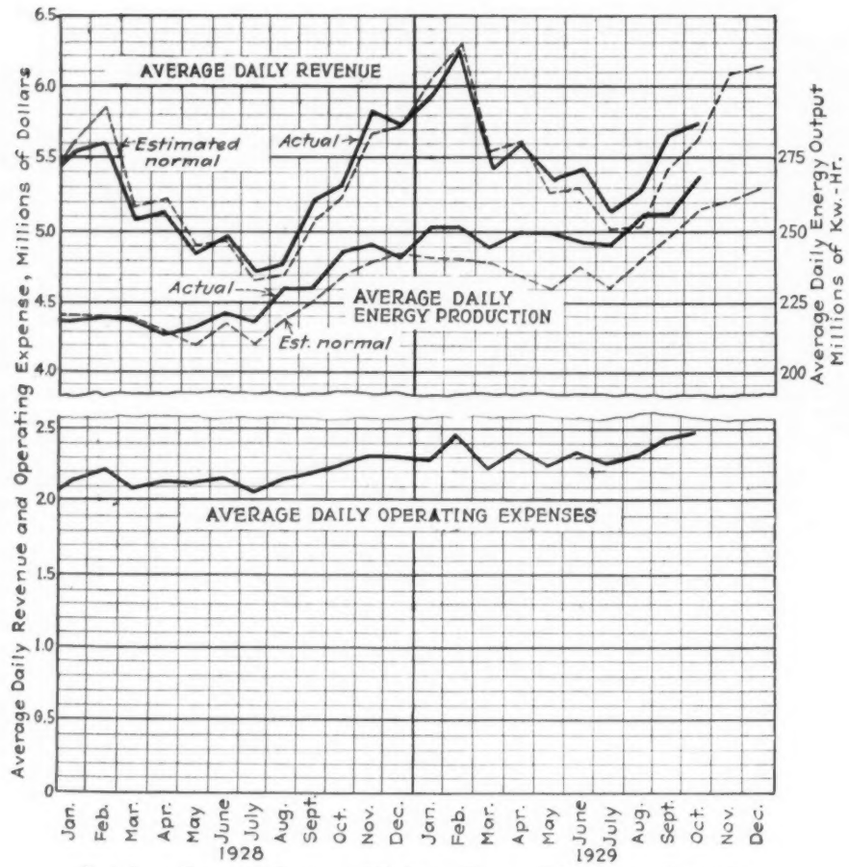
Month	Total Gross Revenue from Sale of Energy*			Total Operating and Maintenance Expense†		
	1929 Thousands	1928 Thousands	Per Cent Inc.	1929 Thousands	1928 Thousands	Per Cent Inc.
July	$159,500	$146,600	+ 8.8	$70,100	$64,100	+9.4
August	163,400	148,600	+10.2	72,150	66,600	+8.5
September	170,100	156,100	+ 9.0	72,250	65,750	+9.9
October	177,800	164,900	+ 7.8	77,070	69,900	+10.2

Table II—Central-Station Fuel Consumption in the United States‡

Compared with Corresponding Month of Previous Year

Month 1929	Coal		Oil		Gas	
	Short Tons	Per Cent Increase	Barrels	Per Cent Increase	Thousands Cubic Feet	Per Cent Increase
July	3,321,853	+15.4	670,580	+26.3	8,842,601	+27.0
August	3,648,175	+15.9	760,996	+29.1	10,317,672	+34.8
September	3,627,955	+15.7	787,617	+33.7	11,160,970	+53.5
October	3,757,999	+ 6.6	1,028,148	+72.6	11,782,786	+51.5

*Aggregate gross revenue from consumers and from other utilities for energy for resale, involving a certain amount of duplication.
†Do not include interest, taxes, depreciation or sinking fund, with some unavoidable exceptions. ‡As collected by U. S. Geological Survey.



October Energy Output Highest Ever—"Summer Droop" Virtually Absent in 1929

51.5 per cent to 11,782,786,000 cu.ft. Further data appear in Table II.

For some months the rate of increase in New England has been notably high. The condition continued in October, in the matter of revenue at any rate. In output gains some other sections stood higher, notably the West Central States, where the increase averaged nearly 16 per cent.

Regional gains are given in Table IV and on the accompanying map.

Table III—Energy Output of Central Stations in the United States

Compared with Corresponding Month of Previous Year

Month 1929	Generated, Thousands of Kw.-Hr.*						Purchased for Resale	
	Total		Hydro		Fuel			
	Generated	Per Cent Inc.	Generated	Per Cent Inc.	Generated	Per Cent Inc.	Thous. Kw.-Hr.	Per Cent Inc.
July	7,644,617	+13.0	2,973,696	—0.1	4,670,921	+23.4	1,610,000	+ 8.2
August	7,963,547	+11.7	2,732,956	— 7.3	5,230,591	+25.2	1,630,000	+ 8.2
September	7,680,180	+10.9	2,372,834	—12.5	5,307,346	+29.9	1,708,000	+14.0
October	8,295,839	+ 9.9	2,638,876	— 5.6	5,656,963	+19.0	1,776,000	+ 9.3

Table IV—Regional Operations, Revenue and Energy Output in October, 1929

Compared with Corresponding Month of Previous Year

Region	Revenue		Energy Generated, Thousands of Kw.-Hr.*					
			Total		Hydro		Fuel	
	Thousands of Dollars	Per Cent Inc.	Generated	Per Cent Inc.	Generated	Per Cent Inc.	Generated	Per Cent Inc.
United States	177,800	+ 7.8	8,295,839	+ 9.9	2,638,876	— 5.6	5,656,963	+19.0
New England	18,070	+10.7	561,782	+ 9.4	118,088	—37.0	443,694	+36.0
Middle Atlantic	45,100	+ 7.6	2,020,483	+10.8	520,890	+12.9	1,499,593	+10.1
East North Central	44,600	+ 6.6	2,031,840	+ 6.5	173,673	—24.1	1,858,167	+10.7
West North Central	14,800	+ 7.7	491,529	+15.9	106,996	—20.7	384,533	+33.0
South Atlantic	18,540	+ 7.5	1,077,031	+15.2	616,702	+27.2	460,329	+ 2.2
East South Central	6,340	+ 5.8	276,792	— 0.9	197,778	—12.2	79,014	+46.1
West South Central	9,870	+10.0	452,478	+15.9	2,379	+85.4	450,099	+15.6
Mountain	4,460	+ 7.5	312,595	+ 1.4	256,429	— 4.3	56,166	+39.5
Pacific	16,070	+ 7.6	1,071,309	+10.4	645,941	—19.6	425,368	+159.0

*As collected by U. S. Geological Survey.

New Capital Issues

Milwaukee Electric Railway & Light Company.
Refunding and first mortgage gold bonds, 5 per cent, Series B.
Amount, $10,000,000.
Price, 99¼ and interest.

Milwaukee Electric Railway & Light Company does the entire commercial electric light and power and steam-heating business in the city of Milwaukee and suburbs, as well as substantially the entire street railway business in the territory. It also furnishes most of the interurban transportation service throughout an extensive surrounding district. This issue is to reimburse the company's treasury for funds provided by it for the payment of $5,000,000 underlying bonds matured last May and for property additions. These bonds are the direct obligation of the company, secured by first lien on certain central station and distribution system properties.

Central Illinois Public Service Company.
First mortgage 5 per cent gold bonds, series G.
Amount, $2,700,000.
Price, 96 and interest to yield 5.25 per cent.
Period, forty years.

Central Illinois Public Service Company provides electrical and other utility service to over 400 communities in central and southern Illinois, serving a population of 550,000. The company is controlled by Middle West Utilities Company.

National Electric Power Company.
Cumulative preferred stock.
Amount, $4,000,000.
Price, $97.25 to yield about 7.20 per cent (with stock purchase warrant).

National Electric Power Company controls a group of utilities furnishing electric light and power and other utilities to 1,907 communities in fifteen States. The corporation is part of the Middle West Utilities system. Each share carries a warrant to purchase one share class B common stock of the company at stipulated prices. The stock is preferred as to assets and dividends.

City of Tacoma, Electric Light and Power System.
First and refunding 4½ per cent mortgage gold bonds series B.
Price $100 and interest.
Amount, $1,500,000.

City of Tacoma Electric Light and Power System issued these bonds for the purpose of making certain additions and extensions to the present electric generating plant and system, and in the opinion of counsel are valid and legally binding obligations of the city of Tacoma, payable, both principal and interest, solely out of a special fund known as "City of Tacoma Electric Light and Power Fund of 1929." The Electric Light and Power System was acquired from private owners in 1893 and has since been in operation, serving the city without competition. Present installed capacity aggregates 94,000 hp., of which 82,000 hp. is hydro-electric, and construction is now proceeding on the installation of 75,000 hp. additional hydro-electric power.

Business News and Market Conditions

Decreased Manufacturing Operations

IN LINE with the November trend of practically every national manufacturing group, the electrical manufacturing plants of the country reported a drop in rate of operations during November. According to reports on electrical energy consumption received by ELECTRICAL WORLD these plants witnessed a drop of 6.2 per cent in rate of productive activity during November, but the rate of activity was still on a plane about 16 per cent above November, 1928. The average rate of operations of the industry during the first eleven months of 1929 was 26.4 per cent above that reported for the same period last year.

November, 1929	169.5
October, 1929	180.6
September, 1929	168.8
August, 1929	155.4
November, 1928	146.4
Average first eleven months, 1929	160.1
Average first eleven month, 1928	126.7

The reports on electrical energy consumption indicate that the larger manufacturing companies are maintaining their productive operations in a better position than the group of smaller companies. The larger companies recorded an average decrease in operations during November of 7 per cent as compared with October, but were still operating on a plane 21.6 per cent above November, 1928. The smaller electrical manufacturing plants recorded a November decrease of 7.7 per cent as compared with October, slightly greater than the rate of decrease recorded by the larger plants, but were still operating at a rate 10.3 per cent above November last year.

The index of activity in the electrical manufacturing industry, based on consumption of electrical energy, stands at 169.5 for November as compared with 146.4 in November last year. Comparative indexes of productive activity referred to the average activity for the period 1923-25 as 100 and adjusted for number of working days are shown in the accompanying table.

Copper Market Quiet

Scarcely any change took place in the market for copper, the price holding at 18 cents delivered in the Connecticut Valley and at 18⅛ cents in the Middle West. The sales total for the week was slightly higher than in the preceding week, but this means little in view of the fact that the daily average was slightly less than 400 tons for the period. The demand for fabricated copper has shown some improvement of late.

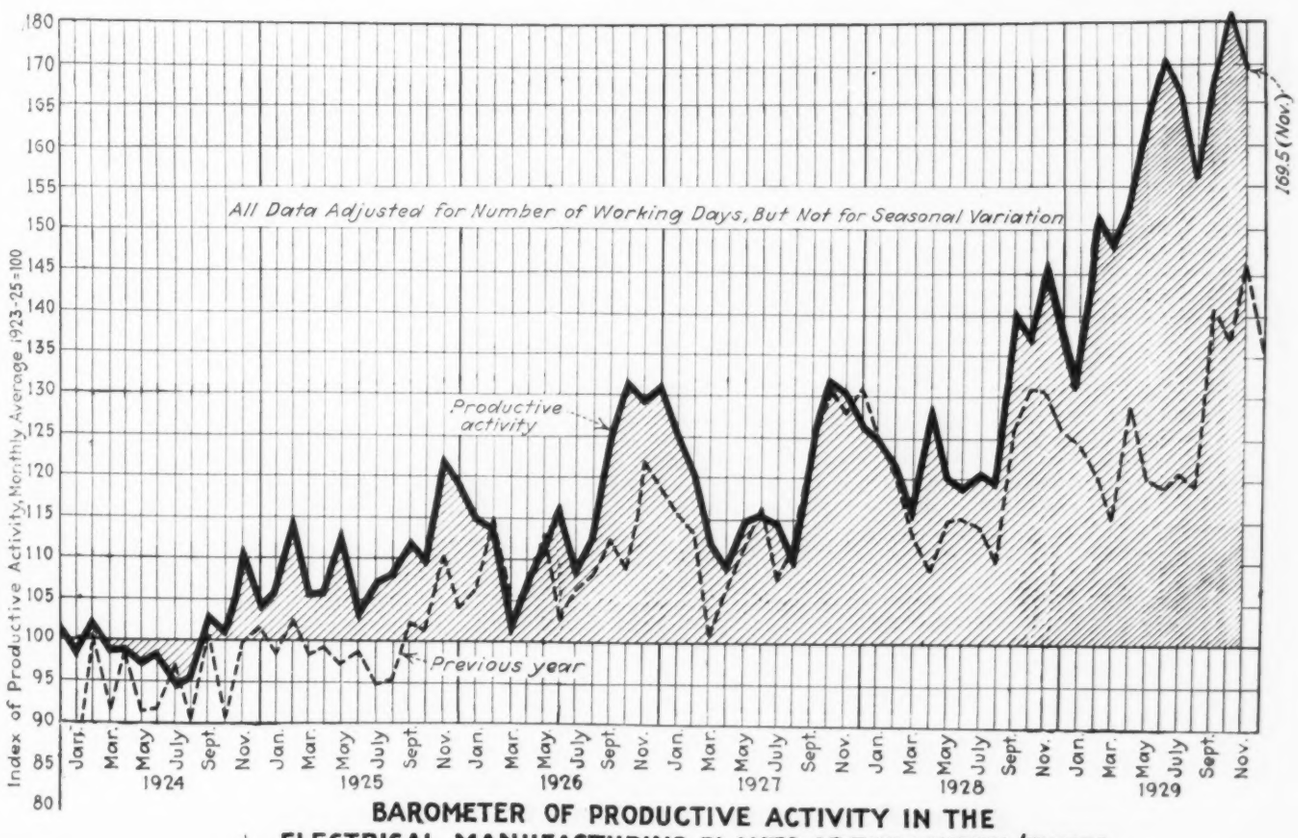
New York Metal Market Prices

	Dec. 18, 1929 Cents per Pound	Dec. 24, 1929 Cents per Pound
Copper, electrolytic	18	18
Lead, Am.S.& R.price	6.25	6.25
Antimony	8⅜	8½
Nickel, ingot	35	35
Zinc, spots	5.85	5.80
Tin, straits	40⅛	39⅞
Aluminum, 99 per ct.	24.30	24.30

Vacuum Cleaner Statistics

A statement of the sales for the vacuum cleaner manufacturers for the early months of 1929 is shown in the accompanying table. The Vacuum Cleaner Manufacturers' Association has changed the method of reporting these figures and they will be reported in this manner, hereafter:

1929		1929	
January	85,501	June	97,397
February	97,114	July	68,000
March	131,448	August	96,382
April	125,876	September	109,529
May	119,298	October	112,506



BAROMETER OF PRODUCTIVE ACTIVITY IN THE ELECTRICAL MANUFACTURING PLANTS OF THE UNITED STATES

Market Conditions

HEAVY EQUIPMENT orders are anticipated for the first quarter of 1930, but seasonal slackness is strongly in evidence this week. The Eastern district anticipates unprecedented demand for railway electrification equipment.

——RAILWAY EQUIPMENT ORDERS are at a high level also on the Pacific Coast and substantial orders are anticipated in the next three months.

——NEW ENGLAND SALES for the year indicate a rise of about 15 per cent in small motors.

——LARGE EQUIPMENT SALES in the Southwest are holding up well, although appliance business has slowed down appreciably.

EASTERN

THE YEAR-END holiday period has brought about noticeable easing in the electrical equipment market in the Eastern district, and while a fair volume of transactions has ensued, commitments are of reduced order.

CENTRAL-STATION account trends to substation and miscellaneous line apparatus, for the most part, while industrial demand is largely for motors, controls and accessories.

ATTENTION is now being directed to the turn of the new year, and with utility and railway budgets of record proportions some heavy orders are anticipated during the first quarter.

Unprecedented demand for equipment for railway electrification is prophesied in the early months ahead. Gross railway budgets approximate $149,000,000 for new construction in 1930, and a substantial proportion of this sum will be diverted to electric account, including line construction, power facilities and purchase of electric and oil-electric locomotives and other equipment. Marine account, also, has a substantial and encouraging outlook during the coming year and manufacturers of electric equipment for this service are looking for some heavy commitments.

A manufacturer of wire and cable says that December business has exceeded that for November, with inquiries showing sizable contracts to be placed in the near future; the year has shown an advance of 20 to 25 per cent over sales for 1928. A northern New York central station has placed an order with a state manufacturer for a quantity of wire and cable to cost about $350,000. A Pennsylvania maker of prime movers will furnish two 15,000-kw. turbo-generator units for an installation in Oklahoma, contracts for boilers being placed with a New York manufacturer. An order for high-tension electrical insulators for a line installation in Texas has been secured by an Ohio manufacturer, with order for line hardware going to a New York maker. A manufacturer of control equipment says that business has been maintained at a satisfactory level throughout the year, with outlook encouraging for the early months of 1930; orders for deliveries in January are at a normal rate.

Iron and steel mills are coming into the market for requirements of heavy type industrial motors and kindred equipment, and active transactions loom ahead for this account. Chemical plants, textile mills, metal-working plants and machinery manufacturers are other prominent prospective purchasers in the market. A manufacturer of cranes and hoists in Michigan is enjoying substantial business; a maker of similar electric equipment in New York reports equally satisfactory account, with inquiries holding well. A company manufacturing domestic electric specialties says that November developed record sales, with December business easing only slightly. Two manufacturers of electric refrigerators in the Middle West are running at capacity schedules and will hold to this basis indefinitely; both have secured the highest volume of business in company histories during November, and the outlook for 1930 trends to still higher levels. There is better demand for street-lighting and airport lighting equipment.

CONSTRUCTION PROJECTS

Consolidation Coal Company, New York, plans coal-handling and distributing plant at Milwaukee, Wis., to cost $1,000,000. Atlas Portland Cement Company, New York, contemplates a mill near Rochester, Minn., to cost more than $700,000. General Baking Company, New York, is carrying out an expansion and improvement program at Detroit, Mich.; Allentown, Pa.; and Washington, D. C., to cost over $1,500,000. Henry Holder, Brooklyn, architect, is preparing plans for a local paint and varnish plant to cost more than $100,000, for company whose name is temporarily withheld. Niagara Falls Power Company, Niagara Falls, N. Y., plans steam-operated electric power plant near Buffalo city limits, reported to cost over $1,000,000. Shell Eastern Petroleum Products Company, New York, plans an oil storage and distributing plant near Trenton, N. J., to cost more than $90,000. Orange, N. J., will make improvements and replacements, including new lighting poles, in street-lighting system. J. Strum & Company, Newark, N. J., will establish a commercial automobile body plant on Wilson Avenue, reported to cost more than $75,000. Eastern New Jersey Power Company, Asbury Park, N. J., will soon begin superstructure for an addition to generating plant at Allenhurst, N. J. American Ice Company, Philadelphia, Pa., will build electrically-operated ice-manufacturing plants at East Boston, Mass., and Branchtown, Philadelphia, to cost more than $500,000. American Bridge Company, Pittsburgh, Pa., plans an expansion and improvement program at steel works at Ambridge, Pa., to cost $1,500,000. Duquesne Light Company, Pittsburgh, Pa., has filed plans for a power substation at Oakmont to cost $40,000, and will carry out an expansion and improvement program in transmission lines, substations and distributing system at Beaver, Pa., and other points in Ohio Valley district to cost $700,000. United States Engineer Office, Pittsburgh, Pa., will receive bids until January 13 for one hydro-electric plant for Lock No. 7, Allegheny River. Chestertown Electric Light & Power Company, Chestertown, Md., plans extensions in transmission lines in Queen Anne's County. General Purchasing Officer, Panama Canal, Washington, D. C., will receive bids until January 2 for six knife switches, copper wire, etc. (Panama Schedule No. 2514). Bureau of Supplies and Accounts, Navy Department, Washington, D. C., will receive bids until January 14 for 10,000 incandescent lamp sockets for the Portsmouth, N. H., navy yard (Schedule 2463). Bureau of Yards and Docks, Navy Department, Washington, D. C., will receive bids until January 2 for an automatic refrigerating machine with accessories for the Charleston, S. C., navy yard (Specification 6029).

SOUTHWEST

THE PAST WEEK has shown the usual seasonal slowing up in some divisions of electrical trade, but manufacturers report the sale of stock sizes of motors and transformers to be holding up very well.

JOBBERS say that there has been more last-minute buying by retailers than usual.

Contracts reported closed include a lot of medium-sized motors for a hydro-electric project to cost $3,000, a 300-kw. rotary converter with transformers, ten motors and switchboard costing $20,000 and cement-making machinery purchased by a local company at a cost of $170,000, of which $35,000 was for two synchronous motors, 1,000 hp. each, with control and miscellaneous electrical equipment.

CONSTRUCTION PROJECTS

Union Electric Light & Power Company, St. Louis, Mo., will build an equipment storage and distributing plant to cost more than $140,000. Southwestern Bell Telephone Company, St. Louis, Mo., plans repeater and cable station at Joplin, Mo., to cost $300,000. Tulsa, Okla., plans ornamental lighting system. Chandler, Okla., contemplates floodlighting system at proposed municipal airport. Foremost Dairy Products, Inc., Texarkana, Ark., plans plant at Little Rock, Ark., to cost $500,000. Arkansas Utilities Company, Helena, Ark., plans ornamental lighting system in business district at Marianna, Ark. Morrillton, Ark., is said to be planning early call for

bids for a municipal electric light and power plant to cost about $100,000. Beaumont, Tex., plans floodlighting system and rotary beacons at municipal airport, project to cost $100,000. Central Power & Light Company, San Antonio, Tex., plans transmission line in Bee County to cost more than $50,000. San Antonio Public Service Company, San Antonio, Tex., plans extensions and improvements in power station on Concepcion Road to cost $900,000. Texas Electric Service Company, Dallas, Tex., will build a transmission line from DeLeon to Ranger, Tex., reported to cost $75,000.

Pacific Coast

PRICES are steadier, such staples as rubber-covered wire and schedule material have increased, collections despite holiday stock purchases are very good and business in all lines is good.

THE ONLY pessimism heard is on seasonable lines, which are reported by dealers to be slow except for cheaper varieties of hollow ware and radios.

RAILROAD business is better than for several years past.

Railroad orders include such active projects as 260 miles of No. 9 bare copper wire and hardware for the Tucson to Nogales four-line-dispatching system, 100 miles for the two-wire San Jose to Watsonville line and 250 miles for the San Luis Obispo to Santa Barbara service. Other railroad business covers material for remodeling shops, cars and roundhouses and for equipping additional cars with interphones. Power company business includes $15,000 worth of poles, mainly 60 and 65 ft., a $100,000 substation for Elsinore, much reconstruction around Stockton and $10,000 worth of 72-kva. regulators for San Francisco. Industrial business is excellent and includes a 400-hp. motor and accessories for a lumber company, a 200-kva. turbine with accessories, value $70,000, for a roofing paper company, a 5,000-piece sign reflector order by an oil company, a $4,000,000 glass factory for Santa Ana, a $5,000,000 soap factory for Long Beach and $20,000,000 worth of plant additions and improvements by the associated oil company, including a cracking plant at Avon. Steel business is expected to be excellent next year due to acquirement by merger of two large plants around San Francisco Bay by the United States and Bethlehem Steel companies, respectively. Contractors are figuring much school and theater work, including schools for Monterey, Los Angeles, Chico, Compton, and San Mateo, and a chain of theaters which include a million-dollar house in Sacramento for Warner and nine theaters in the San Joaquin valley for Fox.

Contrary to expectations and despite the holiday season, Seattle jobbers experienced a good week, sales involving a goodly number of motors, transformers, wiring materials, pumps, etc. The largest order reported, placed with Fairbanks Morse Company for 35 motors, costing about $20,000, involving several hundreds, seventy fives, sixties and fifties, for a $500,000 grain elevator being built for the Port of Tacoma. Other sales reported include 30 machines from 75 hp. down to sawmills and veneer plants; twelve motors from 40 down and pumps for an eastern Washington irrigation district and about 25 from 100 hp. down to scattered mills and industrials. A Puget Sound central station bought a number of small distribution transformers and specifications were issued by a paper company in the Puget Sound district for an initial order of 30 motors from 150 hp. down, the order to be placed after the first of the year. Plans are being formulated by the city of Seattle's municipal lighting department to increase its steam-generating capacity in Seattle, the proposed unit to develop from 10,000 to 35,000 kw., and specifications are expected to be written after January 1. The city of Tacoma revealed plans for $8,375,000 hydro power development through filings with the state hydraulic office at Olympia, asking permission to tap Packwood Lake. Lewis County, and the upper waters of Cowlitz River. The city of Seattle awarded a contract for about $10,000 worth of wiring materials for Diablo dam and bids were opened for thirteen beacons for lighting the Pasco-Spokane airway, involving an outlay in excess of $23,000. Bellingham Ice Company will spend about $25,000 in new building and equipment.

CONSTRUCTION PROJECTS

Glacier County Light & Power Company, Browning, Mont., plans power plant near Glacier Park, Mont., to cost $125,000. Troy Mines Company, Troy, Mont., plans milling plant reported to cost $300,000. Consumer's Pipe Line Company, Conrad, Mont., contemplates oil refining plant to cost about $200,000. Pine Creek Lead-Zinc Mining Company, Wallace, Idaho, plans flotation mill to cost $175,000. Boise, Idaho, plans floodlighting system at proposed municipal airport to cost $150,000. Salt Lake City, Utah, plans ornamental lighting system. Lafayette, Colo., plans ornamental lighting system.

New England

ELECTRICAL equipment sales are quiet in this district. Prominent manufacturers record about 15 per cent increase over last year in small motor sales and show sales of industrial equipment above the volume estimated. For 1930 encouraging prospects loom up in New England.

Turbo-generator sales for the coming year will exceed those for 1929. No slackening in small motor sales appears in view. Scheduled material, switch and control apparatus are in steady demand in this district and will maintain an active trend. The industrial demand is encouraging. In addition sales for marine adaptions are gaining and negotiations are being carried on for control equipment to be used in connection with marine power now projected in a number of New England yards. Railroad electrical equipment sales are active and buying of this type during the coming season is optimistic. Record sales volume is reported by a prominent group of central stations for the current year.

CONSTRUCTION PROJECTS

Boston & Albany Railroad Company, Boston, Mass., has filed plans for power plant at shops at Beacon Park, Allston, to cost $100,000. American Mineral Products Company, Hartford, Conn., will proceed with superstructure for a feldspar grinding mill at Walpole, N. H., to cost more than $90,000.

Middle West

BUSINESS in the Middle West section continues satisfactory. The final period of the year is rapidly closing and from present indications the year will close favorably.

THERE has been a good demand for apparatus with a large demand for distribution equipment.

Some of the interesting orders placed this week include one for ash-sluicing equipment to cost $22,000, seven 333-kva., 12,000-volt, single-phase O.I.S.C. transformers, 47 current transformers, "Mazda" lamps valued at $150,000 and several construction orders aggregating $150,000. Jobbers' sales are normal. The holiday season seems to be coming to a successful close with a large demand for electrical merchandise.

CONSTRUCTION PROJECTS

Wisconsin Power & Light Company, Madison, Wis., plans power plant at Sheboygan, Wis., to cost $40,000. Northern States Power Company of Wisconsin, Eau Claire, has acquired hydro-electric power plant of the Dells Paper & Pulp Company, and will make extensions and improvements to cost $500,000. Bohn Aluminum & Brass Corporation, Detroit, Mich., plans an expansion and improvement program to cost about $1,000,000. Michigan Tank & Galvanizing Company, Detroit, Mich., has purchased a site for a plant to cost more than $100,000, with equipment. Chicago, Burlington & Quincy Railroad Company, Chicago, Ill., plans freight terminal at Galesburg, Ill., to cost $3,000,000. Evanston, Ill., plans ornamental lighting system to cost $1,000,000. Hume Pipe Corporation, Arlington Heights, Ill., will build concrete pipe manufacturing plant to cost $100,000. Victor Soap Company, Chicago, Ill., contemplates a plant to cost about $200,000. United Autographic Register Company, Chicago, Ill., will build a plant to cost about $800,000. Atchison, Topeka & Santa Fe Railroad Company, Chicago, Ill., has approved plans for an engine house and shops at Fort Madison, to cost $100,000. Anaconda Wire & Cable Company, Anderson, Ind., has filed plans for an addition to cost $40,000. Mead Pulp & Paper Company, Chillicothe, Ohio, plans additions to cost more than $200,000. Cincinnati Steel Castings Company, Cincinnati, Ohio, has filed plans for an addition to cost $115,000. Union Storage & Transfer Company, Fargo, N. D., plans cold storage and refrigerating plant to cost $240,000. Duluth, Minn., plans floodlighting system and beacon lamps at proposed municipal airport to cost $260,000. Backus-Brooks Company, Minneapolis, Minn., plans insulating board mill in Finland, an initial unit of group of foreign plants, reported to cost $200,000. St. Paul, Minn., plans ornamental lighting

system. Iowa City, Iowa, plans floodlighting system and beacon lamps at proposed municipal airport to cost $170,000. Lake Mills, Iowa, plans municipal electric light and power plant. Burlington Basket Company, Burlington, Iowa, has plans for plant to cost $250,000.

SOUTHEAST

GENERAL conditions in the Southeast remain as reported last week. The largest central-station order reported was from Alabama for metering equipment amounting to approximately $10,000.

OTHER central-station orders were for 45,000 lb. of stranded bare and 40,000 lb. of weatherproof solid copper wire, and distribution and small power transformers amounting to $3,000.

Bids have been asked on some pole line hardware which, when ordered, will approximate $20,000. A mine locomotive order totaling $13,000 was placed in Tennessee and a steel mill in Alabama ordered 30,000 lb. of varnished cambric lead and rubber covered cable. An ice and cold storage plant in Georgia ordered motors and control equipment amounting to $4,000. Field lighting equipment aggregating $8,000 was ordered for installation at the airport at Tampa, Fla. Sign business is looking up in this section and one manufacturer's agent reports his small sign orders last week totaled $5,000, with prospects for the first few months of the new year excellent. Jobbers report sales of Christmas specialties and radio particularly good. A power company in Georgia just completed a campaign in its rural sections and sold 237 electric water heaters and 181 electric pumps.

CONSTRUCTION PROJECTS

Appalachian Electric Power Company, Roanoke, Va., plans extensions in transmission lines to cost more than $1,000,000. Virginia Electric & Power Company, Richmond, Va., is perfecting plans for a hydroelectric power plant on Roanoke River, near Weldon, Va., to cost about $5,000,000. Richmond, Fredericksburg & Potomac Railroad Company, Richmond, Va., plans warehouse to cost $100,000. American Creosote Works, Louisville, Ky., plans plant at Jackson, Tenn., to cost $250,000. Model Mill Company, Johnson City, Tenn., plans feed mill to cost $100,000. Champion Fibre Company, Canton, N. C., will carry out an expansion and improvement program to cost $250,000. Wilson, N. C., is perfecting plans for extensions and improvements in municipal power plant and system to cost about $200,000. Armstrong-Newport Company, Pensacola, Fla., has approved plans for an insulating board manufacturing plant to cost $750,000.

Activities of the Trade

Westinghouse Receives Order for Booster Converters

The Westinghouse Electric & Manufacturing Company has recently received an order from the Edison Electric Illuminating Company of Boston, Mass., for two 13,000-amp., 60-cycle booster converters with air-blast transformers and starting and running breakers. These machines are to be used, in addition to the present equipment, for supplying additional power to the Edison direct-current system.

One machine will be installed in the company's Arch Street substation and the other in the Carver Street substation. The entire installation will be made by the service department of the Westinghouse company.

The Consolidated Gas, Electric Light & Power Company of Baltimore,, Md., has purchased a 30,000-kva. frequency changer from the Westinghouse Electric Company. The machine will be installed at the company's Westport station. It will be used as a connection between the present 60- and 25-cycle systems and is designed to operate at 300 r.p.m.

GENERAL REFRACTORIES COMPANY has recently appointed the Paxson Taggart Company of Philadelphia, Pa., as its high temperature cement dealer representative in the Philadelphia district and the surrounding counties of Chester, Montgomery and Bucks, also the southern half of New Jersey, as far north as Trenton and Princeton.

Nearly 10 per Cent More Incandescent Lamps Sold

Sales of incandescent lamps in the United States during 1929 were approximately 340,000,000 large and 292,000,000 small lamps, according to a review of the electrical industry for the year by John Liston of the General Electric Company. This is an increase of 18,000,000, or a little over 5½ per cent, in the large sizes over the previous year, and an increase of 37,000,000, or 14½ per cent, in the small sizes.

"These 1929 sales exceed all previous figures, being the largest in the history of the industry," according to Mr. Liston. "On March 1 50- and 60-watt standard lighting lamps of the 115-volt group were reduced in list price from 22 to 20 cents so that the 20-cent price now covers all the generally used lamps up to and including the 60-watt size. The price trend for lamps has been downward for a number of years, the present prices being less than half the so-called pre-war figure.

"Compare this with the present cost of living, which is now 60 per cent above the pre-war level, a peak of 100 per cent increase having been in effect during 1920. While the average prices of lamps did go up during the post-war period, their increase was less than one-tenth that of the increased cost of living during the same period."

Walker Vehicle Buys Barrett-Cravens Company

The consolidation, in ownership and management, of Barrett-Cravens Company with Walker Vehicle Company, Chicago, and Automatic Transportation Company, Inc., Buffalo, is announced.

Walker Vehicle Company, an Insull company, being a subsidiary of Commonwealth Edison Company, has purchased the capital stock of Barrett-Cravens Company, manufacturer of lift-trucks, lift-truck platforms, portable elevators and structural steel storage racks. The Automatic Company is the pioneer manufacturer of electric industrial trucks and tractors, while Walker Vehicle Company is one of the oldest motor truck manufacturers, having been in business since 1903, manufacturing a full line of electric trucks for street use.

HATFIELD ELECTRIC, INC., electrical contractor, announces the opening of permanent offices in the Union Central Life Building, Cincinnati, Ohio, under the management of John O'Connell.

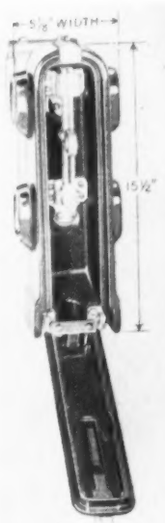
FOX METROPOLITAN PLAYHOUSES, INC., which owns and operates approximately 150 theaters in New York City and New York State, has contracted with Claude Neon Lights for the installation of one or more specially designed neon electric displays on each of its theaters. This is one of the largest orders written by a chain theater organization for electric advertising displays.

SAMSON-UNITED CORPORATION, which recently absorbed the business of the Samson Cutlery Company, has just purchased one of the largest plants in Rochester, N. Y., formerly occupied by the Selden Truck Company. The building is approximately ¼ mile long, covering an area of about 6½ acres, with a floor space of 200,000 square feet. The company manufactures electrical appliances and stainless steel kitchen tools and cutlery.

ARMSTRONG ELECTRIC OFFERS BONDS PRIVATELY.—First mortgage 7 per cent sinking fund convertible bonds of the Armstrong Electric & Manufacturing Corporation to the amount of $300,000 have been placed for private offering. The bonds, callable at $105, are convertible into one share of 7 per cent cumulative preferred stock and five shares of common for each $100 principal amount of bonds. The authorized capitalization of the company consists of 15,000 shares of preferred and 165,000 shares of common stock. Proceeds will be used for paying short-term obligations, for expansion and for other corporate purposes.

New Equipment Available

Porcelain-Housed Disconnect Switch



A 7,500-volt, 400-amp., porcelain-housed disconnect switch of which the housing is wet processed porcelain and glazed both inside and out with protecting arched ridges over entrances for feed wires is announced by Line Material Company, South Milwaukee, Wis.

The porcelain box has a flashover value between terminals and hanger of 45,000 volts dry and 28,000 volts wet. The box is provided with a galvanized steel adjustable vertical hanger which fits all standard crossarms.

The disconnect switch blade is provided with ring handles for use with the ordinary pull stick. The door, which is of bakelite, can be closed with the disconnect switch blade in full open or closed position.

This switch was designed to meet the requirements for a high capacity switch for use on congested poles where the maximum safety had to be considered. When the door of the box is closed with the switch in either the open or closed position no live parts are exposed.

Inclosed Tumbler Switches

A new series of flush tumbler switches wholly inclosed and having both cups and covers made of black bakelite is being offered by the Bryant Electric Company, Bridgeport, Conn. Since the cups are especially shallow, 1⅛ in., there is ample wiring space. Due to construction and special bakelite stops, the switches are quiet in operation.

The switches of this series are No. 3961, single pole; No. 3962, double pole; No. 3963, three point; No. 3964, four point, and No. 3970, single pole quadruple break. The last named is designed for heavy duty.

IMPROVED METER TEST BLOCK.—The States Company, Hartford, Conn., is bringing out a new test block for watt-hour meter checking and relay testing. The block, known as the company's type "SJ," is made up in units attached to a brass strip and contains a shunted jack feature which automatically keeps the secondaries of current transformers closed at all times. The block is manufactured in standard sizes of four, seven, nine and ten poles and is characterized by protection of live parts and a minimum number of connections for a given test service. Meters may be installed or removed without disturbing connections or interrupting service.

Flexible Conduit Fittings

A new line of fittings for flexible metallic conduit known by the trade name of "Jake" is being put on the market by the Hunter-Walker Company, Inc., of Houston, Texas. The fitting screws inside the metallic conduit and has an external clamping ring. The combination of the two makes a positive connecting link between the conduit and the apparatus to which it is attached. It is claimed that the fitting grips firmly and automatically locks the conduit in a uniform manner without tending to collapse the conduit and also that it covers up all ragged edges and supplies a smooth interior surface for the protection of conductors. These fittings are being manufactured in malleable iron, galvanized, for general use and in brass for aluminum flexible conduit.

Turbo-Pump Motor

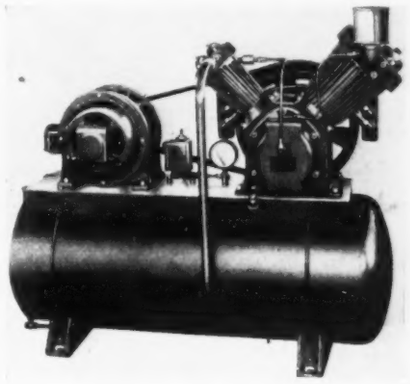
A motor designed primarily for use in operating vertical centrifugal deep well turbine pumps is announced by the U. S. Electrical Manufacturing Company, 200 East Slauson Street, Los Angeles, Calif. The design is made to

co-ordinate with the castings of the pump head so that the finished job appears as a symmetrical unit with motor covered and made waterproof.

It is said to be protected from all atmospheric conditions and is provided with a top plate that permits ventilation but prevents rain and dust from entering the operating parts. The rotor is of solid die-cast aluminum and the entire windings are asbestos-protected with an insulation of "Asbestosite." The motor also embodies the auto-start principle.

Air-Cooled, Two-Stage Air Compressors

A new line of air-cooled, two-stage air compressors, known as type 30, with V-type belt drive, is announced by the Ingersoll-Rand Company. These compressors are of interest in view of the



increasing attention being paid to the advantages of operating steam hammers and similar equipment with air produced by motor-driven compressors.

The units are self-contained, the motor and compressor being mounted on a steel base attached to the top of the air receiver. The latter, made of heavy pressed steel, is built to withstand a working pressure of 200 lb. The intercooler is located behind the fan type flywheel and the constant current of circulating air is driven directly across the cooling coils. This reduces the temperature of discharge air.

It is claimed that this improved two-stage design reduces power from 10 to 30 per cent and at the same time less floor space is required. The compressor is built in four sizes, ¾, 1½, 3 and 5 hp. All sizes are built for a working pressure up to 200 lb. continuous duty.

Ultra-Sensitive Ammeter

To meet the requirements for ultra-sensitive miniature direct-current instruments, the Jewell Electrical Instrument Company, Chicago, Ill., has developed in its pattern No. 88 instruments ranges as low as 200 micro-amperes full scale.

Vacuum thermocouple is an improved design and will handle a 50 per cent overload without difficulty. These instruments are contained in a flush type case of molded bakelite.

These microammeters should prove of value in research work, and may be used as deflection galvanometers in bridge circuits, plate microammeters in vacuum tube voltmeters, and work of a similar sort. In conjunction with proper resistors, they may be converted into voltmeters with a full scale value as high as 5,000 ohms per volt.

Electrical Patents

Announced by U. S. Patent Office

(Issued November 26, 1929)

1,736,861. Spark Producing and Distributing Apparatus for Internal Combustion Engines; V. Paquit, New York, N. Y. App. filed Jan. 25, 1923.

1,736,865. Electrical Generating System; F. F. Starr, Dayton, O. App. filed Aug. 3, 1925.

1,736,887. Electric Plug and Socket; W. J. Pritchett, Sydney, Australia. App. filed Sept. 7, 1927.

1,736,888. Conduit Fitting; H. A. Selah, Erie, Pa. App. filed Dec. 31, 1926.

1,736,899. Electrical Insulation; C. R. Boggs, Waban, Mass. App. filed June 28, 1927.

1,736,979. Thermal Relay; A. J. Mottlau, Pittsburgh, Pa. App. filed Jan. 14, 1927.

1,736,982. Control System for Dynamo-Electric Machines; H. R. Patterson, Poughkeepsie, N. Y. App. filed March 12, 1925.

1,736,986. Protection of Metallic Surfaces Against Incrustation and Corrosion; W. Thalhofer, Vienna, Austria. App. filed Aug. 19, 1925.

1,736,987. Protection of Metallic Surfaces Against Incrustations and Deposits; W. Thalhofer, Vienna, Austria. App. filed Dec. 15, 1926.

1,736,988. Commutator Cylinder; F. H. Tupper, Wilkinsburg, Pa. App. filed March 18, 1927.

1,736,991. All Master, Multi-contact, Pilot Switch; F. B. Adam, St. Louis, Mo. App. filed Dec. 5, 1925.

1,736,994. Current Transformer; E. M. Claytor, Edgewood Acres, and H. E. Cobb, Wilkinsburg, Pa. App. filed Feb. 1, 1927.

1,736,997. Electric Mine Lamp; J. G. Daloz, Courbevoie, France. App. filed June 11, 1926.

1,737,009. Dynamo-Electric Machine; V. A. Fynn, St. Louis, Mo. App. filed Jan. 19, 1928.

1,737,017. Lighting Fixture; T. J. Nelson and E. H. Joseph, Chicago, Ill. App. filed July 23, 1925.

1,737,018. Lighting Fixture; T. J. Nelson, Chicago, Ill. App. filed April 12, 1927.

1,737,019. Composite Piezo-Electric Torsion Device; A. McL. Nicolson, New York, N. Y. App. filed Dec. 20, 1926.

1,737,037. Supervisory Control System; T. U. White, Pittsburgh, Pa. App. filed March 12, 1926.

1,737,039. Preservice Protection of Storage-Battery Electrodes; R. C. Benner, Bayside, and L. C. Werking, New York, N. Y. App. filed Dec. 31, 1923.

1,737,051. Toy Electric Engine; R. Koenig, Two Rivers, Wis. App. filed Aug. 9, 1928.

1,737,063. Variable Radio Tuning Device; C. Smith, Chicago, Ill. App. filed Aug. 20, 1927.

1,737,073. Breeding Kennel; H. Boldt, Appleton, Wis. App. filed April 14, 1927.

1,737,074. Radio Condenser; L. A. Brand, Sioux City, Iowa. App. filed March 9, 1929.

1,737,105. Earthquake Operated Safety Automatic Circuit Breaker; J. L. Blalack, Los Angeles, Calif. App. filed March 28, 1927.

1,737,126. Liquid-Level Indicator; G. Reyling, Mineola, N. Y. App. filed May 24, 1927.

1,737,128. Alternating-Current Induction Motor or the Like; O. A. Ross, New York, N. Y. App. filed Oct. 28, 1925.

1,737,130. Dry Cell; O. W. Storey and J. G. Zimmerman, Madison, Wis. App. filed July 8, 1926.

1,737,147. Frequency Regulation; H. Chireix, Paris, France. App. filed Nov. 10, 1924.

1,737,166. Direction-Signal Switch; D. A. Mace, Eureka, Calif. App. filed May 8, 1928.

1,737,188. Method of Precooking Paste in Dry Cells; L. M. Currie, Lakewood, O. App. filed Aug. 29, 1927.

1,737,205. Fuse; A. G. Steinmayer, Milwaukee, Wis. App. filed Nov. 30, 1925.

1,737,229. Switch for Systems of Automotive Safety Signaling; G. W. Frost, Milwaukee, Wis. App. filed July 19, 1926.

1,737,235. Switch Box; E. T. Hagist, Philadelphia, Pa. App. filed June 6, 1924.

1,737,242. Threadless Coupling; J. W. Hooley, Larchmont, N. Y. App. filed Sept. 5, 1928.

1,737,264. Mechanism for Operating Electrical Contacts and Other Devices; A. S. Newman, London, England. App. filed Jan. 27, 1928.

1,737,293. Enamel Drier; J. E. Birch, Detroit, Mich. App. filed Aug. 29, 1927.

1,737,303. Ammeter-Magnetic Pointer Type; J. E. Eshbaugh, Flint, Mich. App. filed July 15, 1927.

1,737,309. Electric Reel Switch; W. Hermann, Chicago, Ill. App. filed Jan. 20, 1926.

1,737,329. Electric Fuse Holder for Automobiles; J. W. Patrick, Essendon, Melbourne, Australia. App. filed Dec. 22, 1927.

1,737,334. Latch for Electric Switches; D. E. Rohrer, Charlotte, N. C. App. filed Oct. 28, 1925.

1,737,358. Control of Electrically-Driven Reciprocatory Apparatus; J. J. Cooper, London, England. App. filed April 29, 1924.

1,737,387. Electric Motor; A. G. Redmond, Flint, Mich. App. filed May 18, 1925.

1,737,388. Electric Motor; A. G. Redmond, Flint, Mich. App. filed May 18, 1925.

1,737,389. Electric Motor; A. G. Redmond, Flint, Mich. App. filed May 18, 1925.

1,737,425. Electrochemical Process for the Extraction of Copper and Zinc from Ores; H. S. MacKay, London, England. App. filed Jan. 28, 1926.

1,737,445. Dry-Battery Construction; H. R. C. Anthony, Madison, Wis. App. filed May 18, 1928.

1,737,460. Electric Hair Pressing Cap; W. G. Johnson, New Orleans, La. App. filed March 28, 1929.

1,737,471. Weight-Operated Switch; E. A. McNeil, Kenosha, Wis. App. filed June 20, 1927.

1,737,501. Apparatus with Siphon Mechanism for Delivering Different Predetermined Quantities of Liquid; P. Kajanoff, The Hague, Netherlands. App. filed April 18, 1928.

1,737,506. Connecter; L. McCracken, Santa Ana, Calif. App. filed Jan. 5, 1928.

1,737,520. Directory Board; T. P. Richardson, Jr., Tryon, N. C. App. filed Feb. 3, 1928.

1,737,538. Short Circuiting Device; J. D. Karle, Roselle Park, N. J. App. filed Aug. 15, 1927.

1,737,546. Signal for Automobiles; C. R. Safford, Buffalo, and H. O. F. Tauffener, Kenmore, N. Y. App. filed March 17, 1927.

(Issued December 10, 1929)

1,738,515. Electroplating Apparatus; W. E. Belke, Chicago, Ill. App. filed March 31, 1927.

1,738,524. Device for Locking Evacuated Tubes; H. J. Christopher, Westfield, N. J. App. filed Dec. 17, 1924.

1,738,528. Electromagnet; R. R. Dunlop, Columbus, O. App. filed Jan. 26, 1924.

1,738,529. Resistance Unit; R. R. Dunlop, Columbus, O. App. filed March 8, 1924.

1,738,531. Key and Lever Guard for Fire Alarm Boxes; M. J. Grace, Charleston, S. C. App. filed June 30, 1924.

1,738,537. Electric Safety Razor; S. W. Moon, Chicago, Ill. App. filed Jan. 12, 1928.

1,738,538. Electric Vibratory Device; S. W. Moon, Chicago, Ill. App. filed March 19, 1928.

1,738,540. System of Generating and Storing Electricity; J. B. Replogle, and J. M. Lea, Detroit, Mich. App. filed May 19, 1919.

1,738,542. Electrical Apparatus; F. F. Starr, Dayton, O. App. filed Jan. 31, 1924.

1,738,573. Arc Welding; E. S. Goodspeed, Detroit, Mich. App. filed July 22, 1920.

1,738,595. Method for Firing Explosives; L. M. McBride, Boston, Mass. App. filed May 17, 1927.

1,738,651. Electric Current Measuring and Indicating Means; M. J. Huggins, Upper Saddle River, N. J. App. filed Feb. 21, 1924.

1,738,663. Electric Heater; S. Morse, Cleveland Heights, O. App. filed Sept. 24, 1927.

1,738,683. Anti-Theft Electric Light Bulb; S. F. Bashara and J. W. Cain, Houston, Tex. App. filed June 22, 1925.

1,738,688. Float-Operated Circuit Closer; J. R. Brown, Cleveland, O. App. filed Sept. 11, 1922.

1,738,709. Electrical Plug and Socket Connection; H. B. Jones, Evanston, Ill. App. filed Jan. 2, 1925.

plications, principle of operation, instruc-

1,738,710. Method for Identifying Cabled Wires; H. B. Jones, Evanston, Ill. App. filed Feb. 21, 1925.

New Trade Literature

RESISTANCE TESTER.—James G. Biddle, manufacturer of electrical and scientific instruments, Philadelphia, has issued Bulletin 1255 describing the new "Bridge-Weg" resistance tester. This twelve-page booklet describes the product in detail under such headings as outstanding characteristics, applications, principle of operation, instructions for use and price list.

WATT-HOUR METERS FOR ALTERNATING CURRENT.—A fully illustrated catalog, 1929 edition, on watt-hour meters has just been issued by the General Electric Company. The catalog goes thoroughly into the construction and advantages of the various types of meter, using sectional diagrams to illustrate. A chart of prices is added for the various classifications.

AUTOMATIC SIGNALING EQUIPMENT.—The new leaflet No. 20440 fully describes Westinghouse automatic sectionalizing equipment for railway distribution systems. The operation of sectionalizing equipments for use on stub-end feeders, multiple feeders and voltage sectionalizing feeders is discussed, with diagrams and photographs to illustrate. Copies of this leaflet can be procured from the nearest district office or from the advertising department of the Westinghouse Electric & Manufacturing Company at East Pittsburgh, Pa.

ROTARY RAILROAD CAR DUMPERS.—Link-Belt Company, Chicago, has issued a new book describing the Link-Belt rotary railroad car dumper. It illustrates the dumper in various positions and a double page spread points out the main features of its mechanism. Various types of car dumpers have been used successfully for many years in power plants and on the principal loading docks, both on the Great Lakes and the Atlantic Seaboard, where the rapid loading of vessels is of paramount importance. The handling of a large volume of material continuously was formerly necessary, in order to effect economies. Now, with the development of the rotary railroad car dumper described in this book, No. 1004, the economies of the lifting type of dumper have been brought within the reach of those whose unloading requirements are small, it is claimed by the manufacturer.

Foreign Trade Opportunities

Following are listed opportunities to enter foreign markets. Further information can be obtained from the Bureau of Foreign and Domestic Commerce, Washington, by mentioning the number:

Agency is sought in Berlin, Germany (No. 42,820), for electric fruit juice extractors.

Purchase is sought in Cairo, Egypt (No. 42,880), of electric fans.

Agency is sought in Casablanca, Morocco (No. 42,792), for electrical household appliances.

Agency is sought in Geneva, Switzerland (No. 42,795), for electrical household appliances.

Agency is sought in Prague, Czechoslovakia (No. 42,796), for electrical household appliances.

Agency is sought in Berlin, Germany (No. 42,820), for electrical household appliances.

Agency and purchases are sought in Prague, Czechoslovakia (No. 42,864), for electrical household appliances.

Agency is sought in Regina, Canada (No. 42,821), for floor lamps.

Agency is sought in Stockholm, Sweden (No. 42,797), for electric trouble lamps.

Purchase is sought in Addis Ababa, Ethiopia (No. 42,793), of self-contained lighting outfit.

Agency is sought in Casablanca, Morocco (No. 42,792), for electrical motors.

Agency is sought in Geneva, Switzerland (No. 42,795), for electric refrigerators.

Purchase is sought in Tegucigalpa, Honduras (No. 42,884), of electric soda fountain appliances.

Agency is sought in Dresden, Germany (No. 42,788), for electric washing machines.

Agency is sought in Casablanca, Morocco (No. 42,792), for insulated wires and cables.

Purchase is sought in Medellin, Colombia (No. 42,794), of X-ray apparatus.